1. Title Page

The Effectiveness of an HIT-based Care Transition Information Transfer System to Improve Outpatient Post-Hospital Care for Medically Complex Patients

a.k.a

The PITSTOP Project: A Patient Information Transfer System to Outpatient Providers

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2. Structured Abstract

Purpose: To determine whether a health information technology-based intervention to improve provider-to-provider communication and standardize the discharge process will improve medication reconciliation and readmissions rates; patient follow-up, education, adherence, and care satisfaction; and provider satisfaction.

Scope: Medically complex adults (managing at least two chronic conditions) discharged home from an urban hospital to a rural community were eligible to participate. A total of 1,197 patients were randomly selected from 4,300 eligible patients from 185 rural health centers.

Methods: The primary intervention standardized the hospital discharge process by: (1) modifying the current electronic health record system to institute an electronic discharge "check list;" and (2) communicating key patient discharge information to rural primary care providers. A second intervention modified the EHR-based medication reconciliation process. Primary outcomes measures included proportion of patients receiving a 14- or 30-day post-hospital discharge medical follow-up appointment, hospital readmissions and emergent care visits. Secondary outcomes included medication reconciliation, patient medication accuracy, patient medication education, and patient/provider satisfaction.

Results: Receipt of follow-up visit within 30-days of discharge increased between baseline and intervention (63% vs. 75%; $p < 0.01$). Patients receiving a follow-up appointment were 44% and 75% less likely to be readmitted to the hospital or visit the emergency room, respectively ($p<0.01$). Significant improvements ($p<.05$) were observed in EHR medication reconciliation at discharge and during follow-up, accuracy of information collected at admission, and completeness of patient discharge medication list. Provider satisfaction with the efficiency and reliability of the care transition process improved over time ($p < 0.05$).

Key Words: health IT, care transitions, readmissions, medically complex, rural

3. Purpose

Study Objectives

The objectives of this study were to: (1) increase follow-up of medically complex patients by rural health care providers; (2) reduce 30-day readmissions; (3) improve medication reconciliation; (4) increase the proportion of patients accurately taking medications one month post-discharge; (5) increase the proportion of patients reporting receipt of medication education at and following discharge; (6) improve rural provider satisfaction with care transition from hospital to home; and (7) improve rural patient satisfaction with transition from hospital to the rural community setting.

To achieve these objectives, interventions were designed to improve the health information transfer process at hospital discharge through improved communication between patient and provider as well as between inpatient and outpatient providers. The overall goal was to achieve, especially during care transitions, improved quality of care, improved patient safety, and efficient use of health care services.

4. Scope

Background

Nearly one in five Medicare patients were readmitted within 30 days of hospital discharge,[1] costing the federal government an additional $17.5 billion in 2010. The 2010 Patient Protection and Affordable Care Act (ACA) allows the Centers for Medicare and Medicaid Services (CMS) to hold hospitals accountable for their 30-day readmission rates by adjusting payments to hospitals effective in 2013 based on "avoidable" readmissions for pneumonia, acute myocardial infarction (AMI), and heart failure (HF).[2] Jenks et al.[1] reported that only half of Medicare patients re-hospitalized within 30 days had a medical follow-up visit between time of discharge and re-hospitalization. Thus, reducing readmissions and improving care transitions from hospital to home to ensure timely follow-up has become a priority for health care organizations, for both quality and financial reasons.[3]

Medically complex patients, i.e., those managing two or more chronic conditions and commonly taking multiple medications, are at increased risk for readmission. This is particularly true for patients living in rural communities whose providers may not be aware of hospital stay and follow-up needs. Lack of communication between inpatient and rural providers may contribute to rural patients' lack of appropriate follow up post-hospital discharge. A medically complex rural patient population would also almost universally benefit from an innovative program that utilizes key processes from evidence-based models of transitional care that should maximize quality of care improvement, patient and provider engagement, and reductions in costly health care utilization.[4-7] Key processes include effective patient education at time of discharge, accurate and timely communication between inpatient and rural primary care providers, and timely follow-up by a medical provider after discharge from hospital to home.[5,7]

This study examined the effect of standardizing discharge processes using a health IT electronic health record (EHR) system to institute a hospital-wide nurse-led electronic discharge "check list," collate key patient discharge information, and automatically notify regional and rural primary care providers of their patients' recent hospital discharge and post-acute care needs. This study contributes to the literature by describing and examining the effects of an

intervention designed to reduce readmissions by improving provider communication using health IT.

Context

Focus on Medically Complex Patients

The number of patients with complex healthcare needs continues to increase and is projected to reach 81 million Americans by 2020.[8] These are medically complex patients who have two or more interacting chronic conditions, including, but not limited to, asthma, chronic obstructive pulmonary disease, diabetes, hypertension, coronary artery disease, congestive heart failure, inflammatory bowel disease, autoimmune diseases, arthritis, depression, and chronic or relapsing malignancies.[8,9] Interacting conditions may limit life expectancy, restrict available therapies due to contraindications, or result in potential deleterious medication interactions. In general, health care is fragmented and poorly coordinated across treatment settings, often resulting in preventable medication errors, unnecessary hospitalizations and emergent care visits, avoidable adverse health events and patients and providers who are dissatisfied with the health care system.[9]

Hospital discharge is a crucial time for medically complex patients. It is a period of transfer from hospital to home or hospital to continuing care facility that involves a transfer of responsibility from inpatient provider to patient, family and primary care provider. Many key transitions may occur upon discharge: medications are started, altered, or discontinued; self-care responsibilities may increase or change, potentially affecting both patient and family; and patient health status may be at a new level, posing challenges to patients, families and health care providers. At this juncture, it is paramount to ensure that effective planning, coordination and communication processes are in place to avoid adverse events, patient dissatisfaction, and avoidable hospital readmissions.[7,10]

Medical Errors and Adverse Events

Despite hospital accreditation requirements and national hospital organizations' recommendations,[4,11] current systems for discharging patients from hospitals are failing. Nearly half of patients discharged from the hospital experience at least one medical error in medication continuity, diagnostic workup, or test follow-up.[10] In addition, 19-23% of discharged patients suffer from an adverse event, usually an adverse drug event, half of which are considered preventable.[12-14] These errors and adverse events are often the result of a breakdown in communication between inpatient and outpatient provider or patient.[13] Outpatient providers have reported high levels of dissatisfaction surrounding the discharge process for their patients.[4]

Focus on Rural Patients

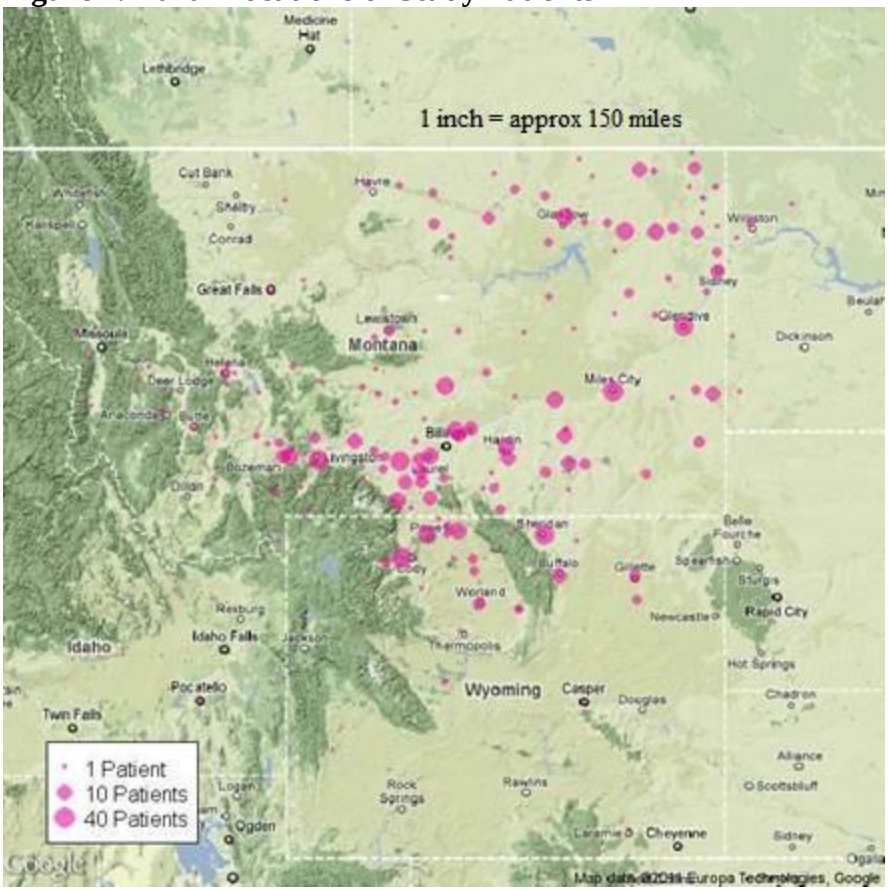
Rural and frontier areas of Montana have unique barriers for disease management of medically complex patients compared to their urban counterparts.[15] Barriers may include a limited availability of health care facilities, health care providers, and health information technology. Rural patients must travel long geographic distances, often in inclement weather, to receive even basic services at rural health facilities. F acilities in rural areas are limited in the services they can provide with 81% of rural Montana communities reporting that there are no specialized health care providers such as cardiologists, ophthalmologists, or endocrinologists available. The majority of Montana's counties have been designated as Health Professional Shortage Areas. Thus, patients with complex health care needs are usually transferred to regional health care organizations, such as Billings Clinic (BC), for inpatient hospital care or outpatient

specialty consultation. The result is that existing rural facilities may be strained with limited or no health IT assistance. BC has adopted a two-pronged health IT approach to rural health care facilities. In the four BC-owned rural primary care clinics, the HIT system has been fully implemented. Providers at affiliated (non-owned) rural health care facilities (hospitals and clinics) can use a web-based provider portal to access clinical information from the BC system. In addition, reference laboratory information is electronically faxed from Billings Clinic to rural clinics. The interventions in this study were developed in the context of the existing health IT structure.

Settings

The study setting was a not-for-profit integrated health system serving 572,000 patients in 40 counties covering a 121,000 square mile region. The 272-bed study hospital had a single EHR shared with four regional rural primary care clinics. Access to the health system's EHR for non-system rural primary care clinics was available through a web-based provider portal. Patients residing in rural communities make up 46% of Billings Clinic hospital admissions and 41% of outpatient visits. Figure 1 displays the rural communities in which study participants resided. This is a good representation of the geographic distribution of patients receiving services at Billings Clinic.

Figure 1. Rural Locations of Study Patients



Participants

Medically complex adults (managing at least two of the following chronic conditions: depression, diabetes, hypertension, heart failure, chronic obstructive pulmonary disorder, coronary artery disease, transient ischemic attack, or cerebrovascular accident) discharged home from an urban hospital to a rural community were eligible to participate. A total of 1,197 patients were randomly selected from 4,300 eligible patients from 185 rural communities.

5. Methods

Study Design

This 4-year prospective controlled intervention study was conducted at Billings Clinic hospital in Billings, Montana and included patients residing in its 121,000 square mile, 40-county service area. An expansion of the initial intervention followed by a medication reconciliation intervention extended the study to 48 months. Figure 2 displays the four data collection periods, number of eligible patients, refusal rates, and patients interviewed. Patients were unable to participate if they were unable to be reached or cognitively impaired without a caregiver willing or able to complete the interview. Patients were not contacted if we had reached our targeted number for that month. Of those interviewed, a subset received Expert Medication Reviews, which are described in detail below.

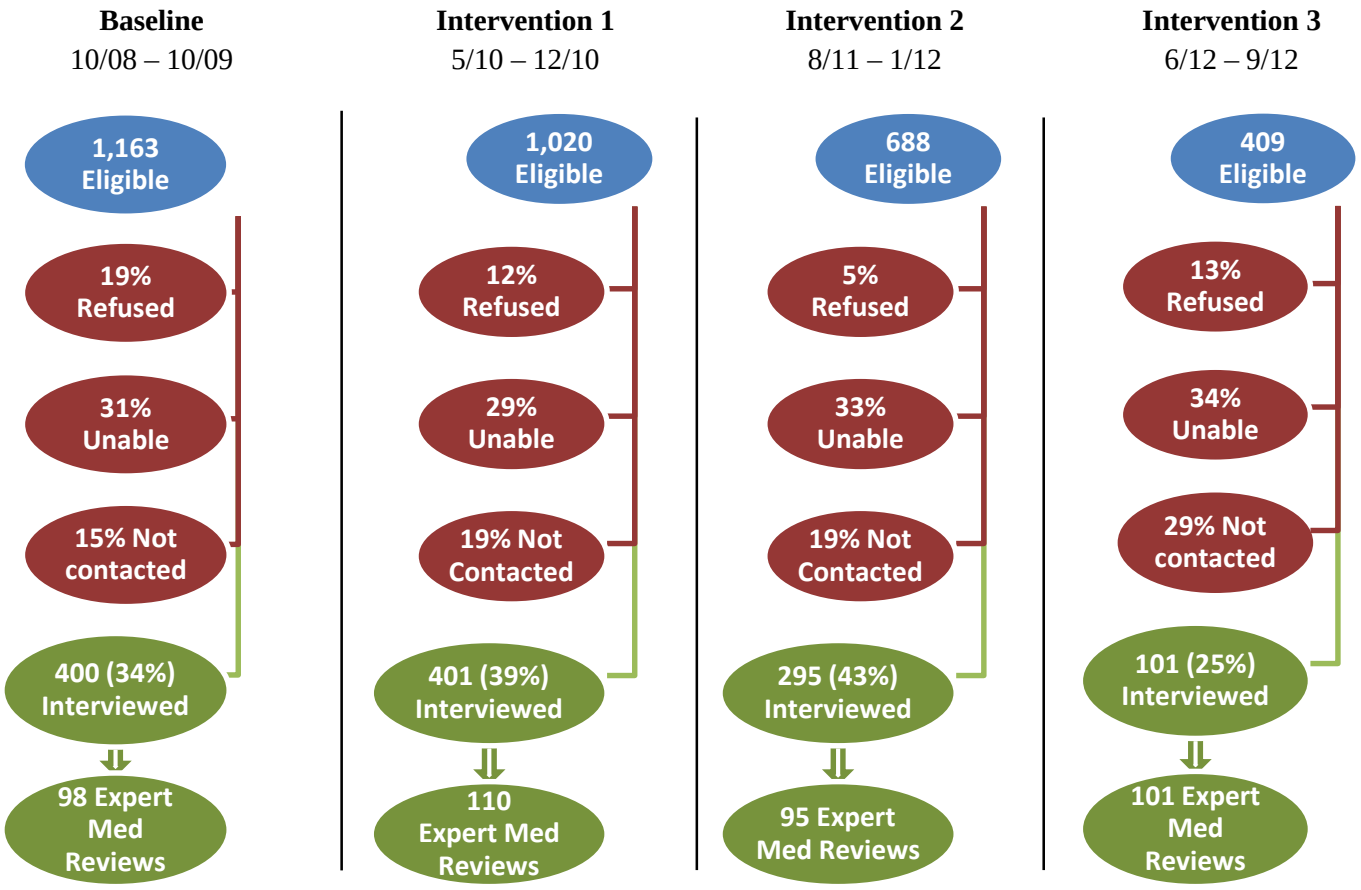


Figure 2. Study Recruitment and Intervention Timeline

Eligibility Criteria

Medically complex adults (managing at least two of the following chronic conditions: depression, diabetes, hypertension, heart failure, chronic obstructive pulmonary disorder, coronary artery disease, transient ischemic attack, or cerebrovascular accident) discharged home from an urban hospital to a rural community were eligible to participate. Patients were considered eligible if they resided in any rural community in Montana, Wyoming, or the Dakotas.

Data Sources/Collection

Telephone interviews were conducted on all study participants. Monthly lists of eligible patients were created and the order of listed patients was randomized. Research Nurses proceeded through the lists until they had successfully interviewed 50 patients per month. In the first months of the study, a total of 50 patients per month was determined to be the saturation point of the patient lists, considering resources and the desire to conduct interviews approximately 30-days post-discharge. Participants were asked detailed questions regarding current medications (name, dose, strength, side effects, prescriber), health care utilization (hospitalizations, emergent, primary, and specialty care visits), and medication education received.

A random sample of patients interviewed during each time period received an "expert review" of their medication data by physician and/or pharmacist experts. (See Figure 2: Study "Recruitment and Intervention Timeline.) An expert review consisted of a comparison between four primary documents: (1) patient interview data; (2) electronic health record (EHR) medication list at the time of patient interview; (3) discharge summary; and (4) patient-friendly medication list generated by the EHR and provided to the patient at time of hospital discharge. A review of these four documents was conducted in order to determine three outcomes related to each medication: (1) was the patient taking each of their medications correctly; (2) was the medication reconciled at time of hospital discharge; and (3) was the medication reconciled at the time of the patient interview. Reasons which could contribute to why medications were not reconciled, i.e., missed opportunities, were captured as "mitigating factors."

Medical chart reviews were also conducted on all participants during which the same utilization and education data were collected as those elicited during the patient interviews. These reviews were completed to confirm the Billings Clinic visits and hospitalizations reported by the patient, realizing that some utilization occurred outside of the Billings Clinic system.

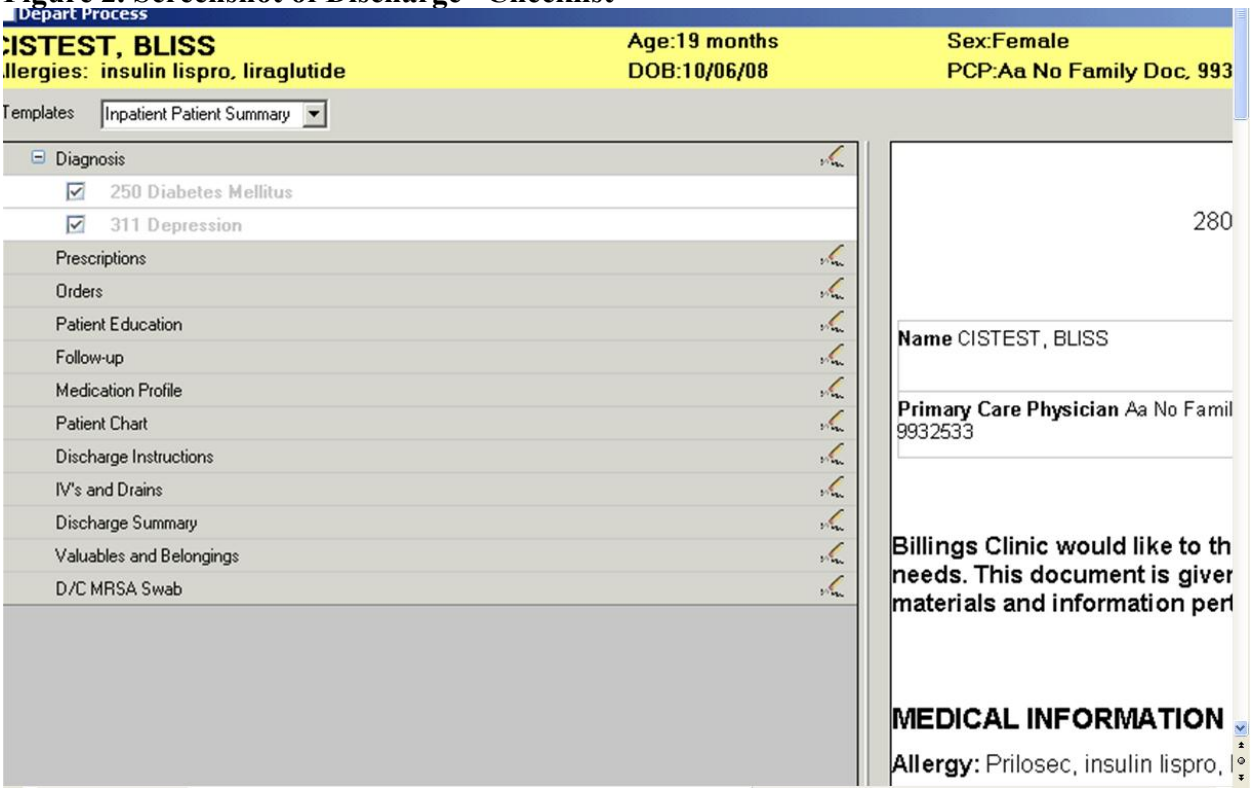
Interventions

Intervention 1

The study conceptual framework was based on Wagner's Chronic Care Model,[16] which identifies the essential elements of a health care system that encourages high-quality chronic disease care. The primary study intervention standardized the hospital discharge process by: (1) modifying the current health IT electronic health record (EHR) system to institute a hospital-wide nurse-led electronic discharge "check list;" and (2) enabling the collation of key patient discharge information for automatic faxing to patients' primary care providers (PCP) located in rural communities. Initially, only primary care providers of patients discharged by Hospitalists received the notifications, but a subsequent expansion of the process resulted in providers of all patients, regardless of discharging provider, receiving the notifications. Discharge information included admission and discharge date, reason for hospital stay, recommended post hospital care, medication lists, scheduled follow-up appointments, and select diagnostic test results. The PCP was directed to access Billings Clinic's EHR using an existing physician portal, or to contact the

attending physician for more information. The checklist was developed by representatives of all hospital units, usually the admission, discharge, and transfer nurses. A screenshot of the discharge checklist is provided below.

Figure 2. Screenshot of Discharge "Checklist"



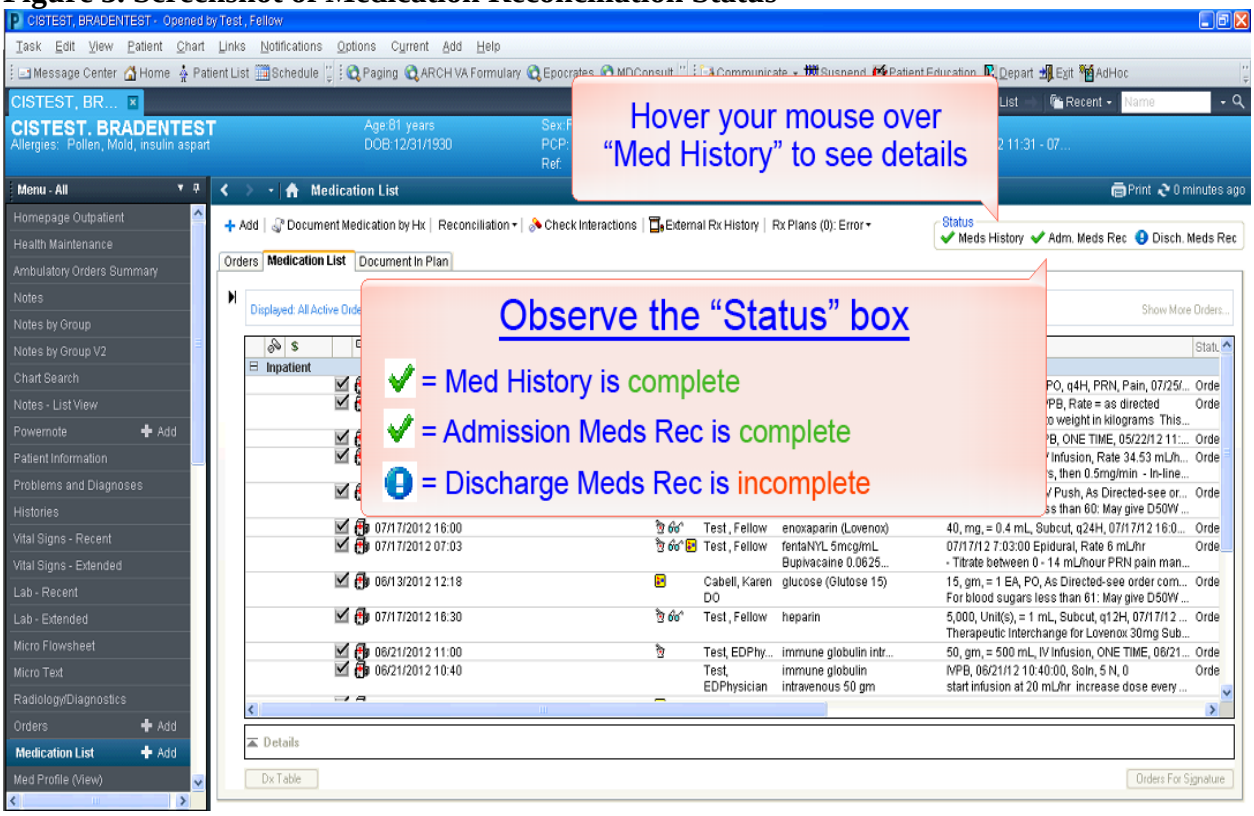
Intervention 2

An extension of the second component of the primary intervention (automatic faxing discharge information to outpatient providers) was implemented fifteen months following the primary intervention in which primary care providers of <u>all</u> patients discharged from the hospital received the intervention. This is referred to in this document as Intervention 2.

Intervention 3

A final medication reconciliation intervention was implemented twenty-four months following the primary intervention. This was a completely independent intervention from the first two and implemented a medication reconciliation process in the EHR that was mandatory for nurses and optional for providers. It consisted of nurses reconciling a medication history on admission ("Meds History") and providers having the option to reconcile medications at admission ("Adm Meds Rec") and/or discharge ("Disch Meds Rec"). A "check box" in the EHR indicated whether a medication was reconciled by a nurse or provider and whether it occurred at admission or discharge (see Figure 3 Screenshot of Medication Reconciliation Status). These data were also collected for each medication in addition to the "expert review" medication data described above. The screenshot below displays the aforementioned check box.

Figure 3. Screenshot of Medication Reconciliation Status



Measures

The primary outcomes examined in this study were in the areas of health care utilization, education, and medication reconciliation. Demographic and clinical data were collected to ensure comparability of comparison groups.

Utilization Measures

The primary utilization measures included the proportion of patients receiving a post-hospital discharge follow-up appointment with their PCP within 14 and 30 days of discharge, and the proportion with a follow-up appointment with a Specialist or other provider within 14 and 30 days of discharge. Participant hospital readmission rates were also examined. Follow-up appointment and hospital readmission data were collected through EHR extraction, as well as through patient telephone interview, to capture visits received outside the Billings Clinic system.

Education Measures

Education measures were collected during patient interview and chart review. Patients were asked if they received education about their medications during their hospitalization, by phone after their hospitalization, or during a follow-up visit. They were asked to specify who provided the education, e.g., physician, nurse, pharmacist, etc. They were also asked if the education included a discussion on the reason for taking the medication, side effects, or special instructions.

Medication Reconciliation

There were three primary measures related to medications: (1) was the patient at the time of the phone interview taking each of their medications correctly; (2) was the medication reconciled on the patient friendly medication list at time of hospital discharge; and (3) was the medication reconciled in the EHR at the time of the patient interview. These measures were determined by the designated Expert Reviewers using the process described above. When a medication in categories (2) or (3) above was not reconciled, a reason was noted for the inconsistency. If the medication was not reconciled at time of hospital discharge, possible reasons included: inaccurate information collected at admission or an unclear/incomplete patient discharge medication list. If the medication was not reconciled at the time of the patient interview, possible reasons included: no EHR update occurred during follow-up visit from system provider, or patient received only follow-up visit with provider outside system. Changes in the reasons for non-reconciliation, i.e., missed opportunities, were examined over time.

Limitations

This type of study was not conducive to randomization of participants. It would have been impossible to utilize a discharge checklist and send notifications for a randomly selected group of patients. It might also have been considered unethical to deny sharing of information to some and not others. Because participants in this study were not randomized, historical control groups were utilized, which can introduce temporal as well as other types of bias.

Patient interviews conducted by telephone may have introduced bias. Since patients needed to be home and able to talk on the telephone, this may have biased the sample to a more healthy population. Patients who were re-hospitalized at the time they were being called, would not be able to participate in the study. Patients too sick to answer or talk on the phone, who did not have a caregiver available to complete the interview, were also excluded.

Reliance on patients' recollections was a possible study limitation. While the interview process included patients collecting their medications, it also relied on patient reports of ambulatory office visits, emergent care visits, and hospitalizations. Often visit and hospitalization dates were approximated. In addition, health care utilization that was reported as occurring outside of the Billings Clinic system could not be confirmed.

Another limitation was the learning curve of the interviewers and the staff turnover. Interviewers may have improved their techniques over time and been more successful in convincing eligible patients to participate in the study. Staff turnover resulted in different interviewers who, although instructed to follow protocols, may have introduced bias based on individual characteristics and personalities when conducting a patient interview.

The medication reconciliation component of the study presented a challenge in terms of resources, data management and clean up, and interpretation of results. Determining whether a medication was reconciled was a resource-intense task requiring the expertise of a physician or pharmacist. The medically complex study patients were discharged with many medications (an average of 9.7 – 11 per patient). Each medication took from 5 to 60 minutes to reconcile and the final reconciliation decision was not always clear. Often several expert reviewers were required to reach consensus among the 4,941 medications reviewed.

Finally, causal effects are difficult to determine because many activities took place during this time period focusing on reducing readmissions, or that could have influenced the results. For a short time during the study, Billings Clinic was engaged with Project BOOST (Better Outcomes for Older Adults through Safe Transitions.) Project activities included patient "teach

back" (having patients repeat discharge instructions to a health care professional) and patient call backs. In addition, other activities were occurring across the organization that may have impacted results such as patient call backs on the surgical unit, targeted discharges, and participation in a community care transition program with the CMS's regional Quality Improvement Office (QIO).

6. Results

Principal Findings

There were 4,300 medically complex patients determined to be eligible for the study. Approximately 28% (1,197 patients) were available and willing to participate in the study. There were 400, 401, 295, and 101 patients in the baseline, and intervention groups 1-3, respectively. Patient characteristics by study group are summarized in Table 1. Significant differences between groups were noted for sex, hypertension diagnosis, and mean numbers of medications per patient, although the latter was not clinically meaningful. Differences in percent of patients with a hypertension or COPD diagnoses should not have an impact on results. These two conditions are just two of eight possible diagnoses participants could have had.

Table 1. Patient Characteristics by Study Group

	Baseline (n = 400)		Intervention 1 (n = 401)		Intervention 2 (n = 295)		Intervention 3 (n = 101)		p value*
	n	%	n	%	n	%	n	%	
Rural Clinics	109	NA	103	NA	92	NA	43	NA	
Females	173	43%	185	46%	107	36%	33	33%	0.01
Diagnoses:									
Hypertension	256	64%	335	84%	248	84%	82	81%	<0.01
Diabetes	177	44%	182	45%	135	46%	48	48%	0.94
Depression	50	13%	74	18%	47	16%	14	14%	0.13
Heart Failure	75	19%	84	21%	75	25%	21	21%	0.20
Cerebral Vascular Accident	29	7%	23	6%	15	5%	3	3%	0.39
Transient Ischemic Attack	5	1%	5	1%	3	1%	5	5%	0.07
Chronic Obstructive Pulmonary Disease	44	11%	63	16%	51	17%	7	7%	0.01
Coronary Artery Disease	177	44%	194	48%	152	52%	53	52%	0.21
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p value** **
Age	66.5	11.0	67.2	11.0	68.6	11.3	68.6	11.8	0.24
#Medications	9.7	4.3	10.8	4.4	11.0	4.0	10.4	3.9	<0.01

* Calculated using a chi-squared goodness-of-fit statistic; ** Calculated using a one-way ANOVA

Note that Intervention 3 sample size was powered to address questions related to medication reconciliation only and therefore was intentionally excluded from Tables 2 and 3 below.

Post-Discharge Follow-Up

A comparison of the proportion of patients receiving 14- and 30- day post-hospital discharge follow-up visits from either a PCP or any health care provider revealed a significantly greater proportion of medical visits in the intervention groups when compared with the baseline group for 14- and 30-day follow up. These data are summarized in Table 2.

Table 2. Post-Hospital Discharge Follow-Up Visits

	Baseline (n = 400)		Intervention (n = 401)		Intervention 2 (n = 295)		p value*
30-Day Primary Care Provider (PCP)	161	40%	197	49%	173	59%	< **0.01**
30-Day Any Health Care (HC) Provider	254	64%	301	75%	250	85%	< **0.01**
14-Day PCP	124	31%	146	36%	138	47%	**<0.01**
14-Day Any HC Provider	180	45%	215	54%	202	69%	**<0.01**

*Calculated using a chi-square goodness-of-fit statistic

Readmissions and Emergent Care Visits

Readmission rates and emergent care visits were examined by treatment group as well as independently by receipt of 30-day medical follow-up appointment. While no effects were detected by treatment group, patients who received a medical follow-up visit were 44% less likely (OR=.56) to be readmitted to the hospital (95% CI: 0.32 – 0.96) and 75% less likely to have an emergent care visit (95% CI: 0.17 – 0.38). Stratification by study group revealed a similar pattern; readmission rates for patients receiving a 30-day medical follow-up appointment were significantly lower than among those without any follow-up (baseline: 2.0% vs. 7.9%; intervention: 3.7% vs. 5.8%; intervention 2: 6.9% vs. 8.3% ($p<.05$). Similarly, emergent care visit rates were significantly lower for those patients receiving a 30-day medical follow-up appointment for each study group (baseline: 3.3% vs. 14.6%; intervention: 7.1% vs. 24.3%; intervention 2: 8.0% vs. 20.0% ($p<.05$). These data are summarized in Table 3.

Table 3. 30-day Readmissions by Post-Hospital Discharge Follow-Up Visits

	30-day Medical Visit (n=791)		No Visit within 30 days of Discharge (n=304)		Odds Ratio*
30-Day Readmission	33	4.2%	22	7.2%	**.56**
30-Day Emergent Care Visit	47	6.2%	63	19.0%	**.25**

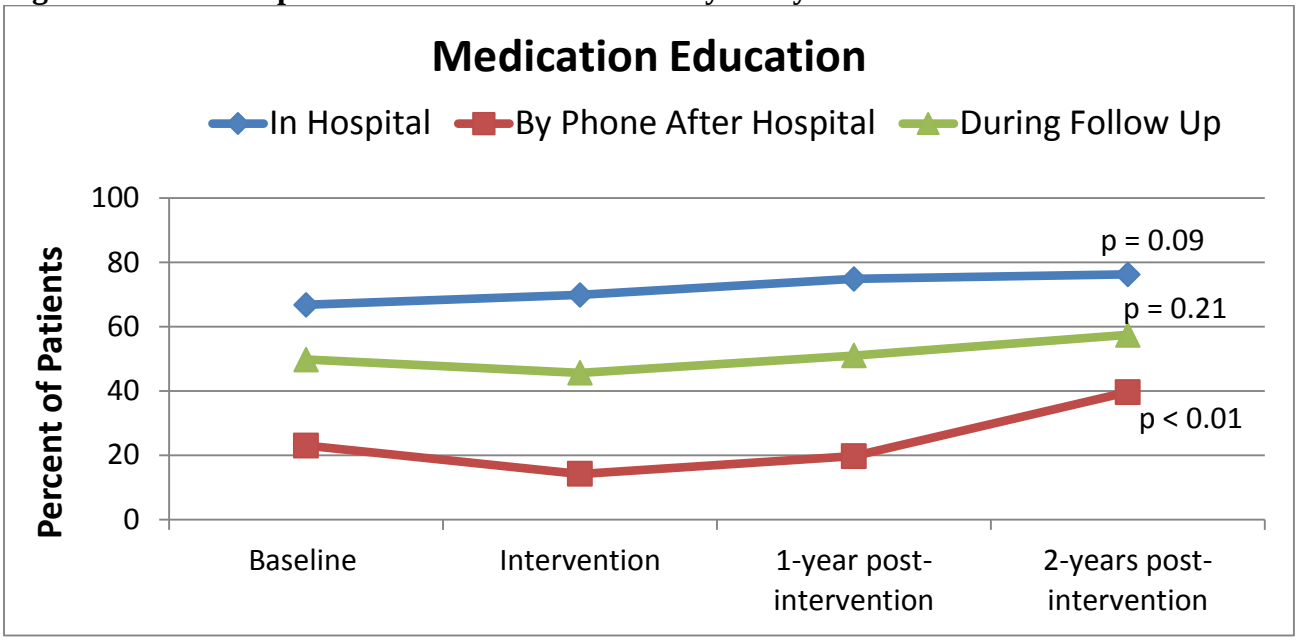
*Calculated logistic regression analysis including terms for study group and follow-up visit.

Medication Education

Improved medication education was a potential outcome of the initial intervention. The hypothesis was that by streamlining and standardizing the discharge process, nurses and providers would be more efficient during the discharge process, and therefore have more time for

medication education, and would also be more likely to remember to provide education, as it became an item on the discharge check list. In the case of medication education, interventions 2 & 3 could be considered follow up data collection periods, as medication education was not a focus of these subsequent interventions. By two years post-Intervention 1, patients were more likely to have reported receiving education on their medications by phone after the hospitalization ($p < 0.01$) and were trending toward improvement in the hospital ($p=0.09$).

Figure 4. Patient Reported Medication Education by Study Time Period



Details of the medication education reported by patients are included in Table 4. Significant improvements were observed in the proportion of patients receiving education on the reason for taking their medications, possible side effects, and special instructions ($p < 0.01$).

Table 4. Details of Medication Education

	Baseline (n = 400)		Intervention 1 (n = 401)		Intervention 2 (n = 295)		p value*
	n	%	n	%	n	%	
Reason for Taking Medication	190	62%	239	74%	222	87%	<0.01
Possible Side Effects	172	56%	189	59%	181	71%	<0.01
Special Instructions	171	56%	217	68%	185	73%	<0.01

Medication Reconciliation

The mitigating factors listed in Table 5 below were determined by the Expert Reviewers when a medication was not reconciled either on the EHR at time of patient interview, or on the Patient Medication List at time of discharge. Table 5 reveals statistically significant improvements in the proportion of patients with factors such as "no EHR update during follow-up visit by system provider" and "unclear/incomplete patient discharge list." In contrast, an increasing proportion of patients were seen only by an outpatient provider outside of the system

who would not have been able to alter the EHR, or had incorrect information collected at admission, although results associated with the latter reason fluctuated over time and warrant further investigation.

Table 5. Mitigating Factors to Medication Reconciliation (Patients Level)

	Baseline (n=97)		Intervention 1 (n=110)		Intervention 2 (n=95)		Intervention 3 (n=100)		p-value
	n	%	n	%	n	%	n	%	
Non-System Outpatient Provider Visit Post-Discharge Only	24	25%	35	32%	25	34%	58	58%	< .01
No EHR Update during Follow-Up Visit	75	77%	72	65%	66	69%	57	57%	0.02
Inaccurate Information Collected at Admission	63	65%	52	47%	29	31%	71	71%	< .01
Unclear/Incomplete Patient Discharge List	43	44%	35	32%	47	49%	24	24%	< .01

The overall effect on medication reconciliation is indicated in Table 6. Effects are displayed by patient and by medication. For a patient to have a correct EHR at time of interview, all of that patient's medications were required to be correct. The same rule applied to a correct patient-friendly medication list generated by EHR at discharge, and patient taking medications correctly at time of interview. All medications had to be correct for that patient to qualify as correct.

When medication reconciliation was considered by medication, the patient-level clustering was removed. Each medication was considered as correct or incorrect. Similar trends are noted when reviewing medication reconciliation at both levels. Percent of patients or medications correct increased at discharge and time of interview, and percent of patients taking their medications correctly decreased.

It is important to examine Tables 5 & 6 together. Note that modest improvements in EHR medication reconciliation at the time of patient interview noted in Table 6 may have been mitigated by the increasing proportion of patients exclusively visiting non-system providers after discharge shown in Table 5. These providers would not have been able to modify the EHR. Similarly, medication reconciliation improvements observed in Table 6 may have been mitigated by the increasing proportion of patients with inaccurate information collected at admission and presumably carried over through discharge, and possible until the time of patient interview.

Table 6. Medication Reconciliation Patient and Medication Levels

By Patient	Baseline (N = 98)		Intervention (N = 110)		1 Year Post (N = 95)		2 Years Post (N = 101)		p-value
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
EMR Correct at Interview	5	5%	10	9%	11	12%	6	6%	0.31
Patient Friendly Med List Correct at Discharge	16	16%	21	19%	30	32%	21	21%	0.06
Patient Correct at Interview	39	40%	33	30%	18	19%	17	17%	<0.01
By Medication	**Baseline (N = 1120)**		**Intervention (N = 1429)**		**1 Year Post (N = 1159)**		**2 Years Post (N = 1233)**		**p-value**
	n	%	n	%	n	%	n	%	
EMR Correct at Interview	717	64%	786	55%	767	66%	829	67%	<0.01
Patient Friendly Med List Correct at Discharge	844	75%	924	65%	885	76%	972	79%	<0.01
Patient Correct at Interview	962	86%	1144	80%	929	80%	994	81%	<0.01

Provider Satisfaction

Between Baseline and Intervention 1, providers' opinions of the discharge process improved significantly as demonstrated in the Table 7 below.

Table 7. Provider Satisfaction with Discharge Process: Response Always or Usually (n=150)

	Baseline	*Intervention*	*p-value*
The care transition process for patients discharged from the hospital to the rural outpatient setting is efficient and reliable and results in quality patient care.	38%	63%	0.015
Outpatient providers receive sufficient or information from the hospital regarding their patients after discharge.	29%	47%	0.064
Outpatient providers receive timely information from the hospital regarding their patients after discharge.	30%	49%	0.061
I believe my patients are getting adequate information regarding their medications, including a patient-friendly reconciled medication list, at time of hospital discharge	60%	80%	0.04
Outpatient providers usually receive a reconciled patient medication list for their patients discharged from the hospital before patients attend a follow up visit.	31%	59%	0.004

Patient Satisfaction

Table 8 presents results over time on patient satisfaction with the factors related to discharge. While the proportion of patients responding "strongly agree" or "agree" increased over time for 10 out of 13 measures, none of the improvements were statistically significant (p=0.12 – 0.93).

Table 8. Patient Satisfaction with the Discharge Process: Response Agree or Strongly Agree

	Baseline n=172	Intervention 1 n=154	Intervention 2 n=102	Intervention 3 n=54	Change
Before I left the hospital, the staff and I agreed about clear health goals for me and how these would be reached.	92.8%	90.3%	91.2%	94.3%	+
When I left the hospital……					
I had all the information I needed to be able to take care of myself.	92.9%	92.2%	92.1%	90.5%	-
I clearly understood how to manage my health.	88.0%	90.1%	89.1%	90.6%	+
I clearly understood the warning signs and symptoms I should watch for to monitor my health condition.	87.0%	87.4%	92.0%	88.6%	+
I clearly understood the purpose for taking each of my medications.	92.8%	89.9%	88.2%	96.1%	+
I clearly understood how to take each of my medications, including how much I should take and when.	94.1%	89.5%	92.1%	96.2%	+
I clearly understood the possible side effects of each of my medications.	75.9%	73.3%	79.2%	79.2%	+
I had a readable and easily understood written list of the appointments or tests I needed to complete within the next several weeks.	93.4%	86.6%	90.9%	94.3%	+
I had a readable and easily understood written plan that described how all of my health care needs were going to be met.	80.2%	78.6%	83.7%	84.9%	+
I had a good understanding of my health condition and what makes it better or worse.	88.7%	86.4%	87.0%	86.8%	-
I had a good understanding of the things I was responsible for in managing my health.	89.9%	91.9%	90.1%	94.4%	+
I was confident that I knew what to do to manage my health.	87.5%	88.7%	87.3%	90.6%	+
I was confident I could actually do the things I needed to do to take care of my health.	91.6%	90.8%	88.0%	90.6%	-

Discussion

In the last decade, much attention has been placed on improving the care transition process in an attempt to improve quality of care, reduce avoidable readmissions, and ultimately lower health care costs. The level of attention to this issue, particularly by health care systems, has recently escalated with the passage and upholding of the 2010 Affordable Care Act, which allows the Centers for Medicare and Medicaid Services (CMS) to hold hospitals accountable for their 30-day readmission rates through payment adjustment. As a result, the already substantial body of literature on the topic has significantly increased. Hospitals are implementing established methods to reduce readmissions, testing new methods, or both, and are capitalizing on various available resources, such as health IT.

This health-IT based project presents one organization's solution to improving care transitions through improved communication between inpatient and outpatient providers through an enhanced discharge process. Results are encouraging: *within 30-day post-hospital follow-up of discharged medically complex patients living in rural communities significantly increased over time.* The literature-supported link between receipt of post-hospital follow-up appointment and reduced readmissions and emergent care visits was expanded in this study to include a broader non-Medicare population. This is critical as more patients are receiving post-discharge follow-up and therefore fewer emergent care visits and re-hospitalizations.

In addition, because study patients were not selected to receive different services, all patients benefited from the interventions, including lower acuity patients and those living in urban settings. Education on medications improved over time, especially by phone following a hospitalization, potentially indicating a connection between notifying rural primary care providers of patient's hospital discharge to ensure closer post-hospital follow-up. Increasing proportions of patients reported receiving education on the reasons for taking medications and possible side effects, suggesting increased understanding in these areas, possible due to more thorough discharge and more complete follow-up. This study demonstrates that simple health IT solutions may have a large impact on patients. Improving communication has long been touted as an important step for creating change in complex adaptive systems such as health care organizations. This project, which targeted improved communication, had a significant impact on post-discharge follow-up that could lead to significant reductions in avoidable readmissions and emergent care visits, keeping patients in their homes and out of the hospital.

A secondary focus of this study was medication reconciliation where positive findings also emerged. *Significant improvements were observed when patients were seen post-discharge by a provider within the system. System providers became better at reconciling medications over time.* Ironically, as more patients received post-discharge follow-up, there may have been increased instances in which patients visited non-system providers, who did not have access to update the study health system's EHR. Therefore, observed improvements by system providers may be underestimated. Health information exchanges could help address this issue and currently an exchange is under development in Montana.

Results were not as strong for medication reconciliation during the hospitalization itself revealing that implementing an electronic system cannot in itself be automatically equated to improved medication reconciliation. Study findings suggested that inaccurate information continued to be collected at admission over time, with observed fluctuations that deserve further investigation. When a provider views a checkbox in the EHR indicating that a medication history has been reconciled at admission (as occurred post-Intervention 3), an assumption that the information is accurate may be made and carried to discharge, regardless of the actual accuracy of collected information. Hospital admission can be a chaotic period of time and it is easy to collect inaccurate information from patients and families. This indicates a need to continue to solicit accurate pre-hospital medication information from patients and families throughout the hospital stay. Study findings indicate that when this measure improved, EHR medication reconciliation improved as well. Therefore this is an important area for future focused intervention.

Medication reconciliation is a complex process, with many opportunities before, during, and after a hospitalization to capture accurate information and maintain an accurate EHR. This study dissected medication reconciliation and the reasons for non-reconciliation, including when and where it occurs. As a result, there is a better understanding of medication reconciliation processes as a whole, and areas for targeted improvement have emerged.

All of the medication reconciliation results warrant further investigation. In an attempt to better understand the study findings, plans are underway to further stratify medications by prescription status, other medication classifications, provider, and admitting and discharge diagnosis. Patients who received post-discharge care outside of the system may be examined separately to determine if observed effects were weakened by this phenomenon. The potential effects on outcomes of number and types of medications, and number and types of chronic conditions will also be examined.

Conclusions

The results of this study demonstrate how a health IT intervention, focusing on discharge standardization and improved provider communication, may improve follow-up of medically complex patients post-hospitalization, leading to reductions in readmissions. Sixty-three percent of patients at baseline compared with 75% of patients post-intervention received a medical follow-up appointment within 30 days of hospital discharge ($p < 0.01$). Further, receiving a within 30-day medical follow-up visit was associated with reduced readmission rates and post-discharge emergent care visits ($p < 0.01$). Significant improvements ($p<.05$) were observed in EHR medication reconciliation at discharge and during follow-up, accuracy of information collected at admission, and completeness of patient discharge medication list. Provider satisfaction with the efficiency and reliability of the care transition process improved over time ($p < 0.05$). These findings have potentially significant clinical and financial implications for hospitals facing reimbursement adjustments by CMS for avoidable readmissions in the near future. While replication of findings at other study sites is warranted, there is little risk in implementing similar interventions to improve provider to provider communication and the discharge process overall and should be encouraged.

Implications

This research has potentially profound implications for health care. Improving communication between inpatient and outpatient providers will be crucial while the health care environment continues to shift until a sustainable model emerges and settles. Changes in health care include imposed payments by CMS for avoidable readmissions, the development of patient-centered medical homes, accountable care organizations, and bundled payments, to name a few. Each will present challenges to health care organizations struggling to adapt, adjust, and make ends meet. Communication is essential as the care and cost of caring for patients is shared across care settings. Creating new ways to improve communication through use of health IT can only lead to better care of patients, and reductions in unnecessary costs.

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