

***Grant Final Report***

**Grant ID: R18HS017795**

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**Improving Care Transitions for Complex Patients  
through Decision Support**

**Inclusive Project Dates: 09/30/08 – 09/29/12**

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**Submitted to:**

**The Agency for Healthcare Research and Quality (AHRQ)**

**U.S. Department of Health and Human Services**

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# Structured Abstract

**Purpose:** To develop and evaluate a decision support system that will increase the availability of clinical information at ambulatory care practices following three types of care transitions (hospital discharges, emergency department encounters and specialty care evaluations).

**Scope:** n/a

**Methods:** We developed a health information system to detect care transitions and then send information about these detected care events to patients, ambulatory care providers and care managers, thus, supporting both traditional clinic-based models of care and new care models including population health management and cross-disciplinary teams. The system was based on HL7 standards for decision support and utilized routinely available claims and scheduling data in order to serve as a replicable model for broader use of decision support for handling care transitions. When the decision support system detected a care transition, four information interventions could be created: (1) care event summary reports faxed or emailed to the patient's medical home, (2) patient letters containing information similar to that in the care event summaries with reminders of scheduled appointments and health education material as appropriate, (3) release of information requests sent to the health information management department of the care encounter site on behalf of the patient's medical home, and (4) care event notices regarding the care encounters that were emailed to the patient's assigned care manager. To evaluate these interventions, 8422 complex patients were randomized to (1) usual care (n=2281), (2) an intervention that combined care event summaries, patient letters, and releases of information requests (n= 2240), or (3) the combination of all four interventions (n=3482).

**Results:** During the study period, the decision support system functioned as designed and was able to detect care transitions for this study's complex patients and provide relevant information to ambulatory care practices, patients, and care managers and to increase the number of care manager contacts for patients in the third study group versus the control group. However, there were no differences in encounter rates (outpatient, emergency department, and hospitalization) among the three study groups. Although there were no treatment-related differences in total medical costs, patients receiving all four interventions had somewhat higher pharmacy costs versus patients in the usual care group. One of this study's challenges was to effectively integrate new information sources into the existing workflows of busy ambulatory clinics. Audits at study sites reported that study-related clinical information was only available in a little over half of cases for which transitions had been detected.

**Key Words:** clinical decision support; evidence-based pharmacotherapy; population health management; computers in healthcare; Medicaid; healthcare utilization; healthcare costs; healthcare quality

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# Final Report

## Purpose

The use of Health Information Technology (HIT) has been identified as a promising strategy for improving the quality and safety of health care. Systematic reviews have found that HIT interventions can increase adherence to guideline-based care, decrease medication errors, and enhance chronic disease management.<sup>1,2</sup> In particular, the proactive delivery of patient-specific CDS at the point of care has been consistently shown to be an effective approach for improving care quality.<sup>3</sup> The purpose of this project was to increase knowledge and understanding regarding the use of clinical decision support (CDS) for improving outcomes, quality, and coordination of care within a vulnerable population; to assess the impact of this technology on service utilization and costs; and to demonstrate a generalizable approach in a community setting that can be replicated at other sites.

## Scope

### Background

Suboptimal care transitions constitute a significant cause of morbidity, mortality, and excess healthcare costs in the United States.<sup>4-11</sup> Such suboptimal care transitions result from a fragmented healthcare system in which care is inadequately coordinated and relevant information is not effectively communicated among providers, patients, and their caregivers.<sup>6</sup> The negative consequences of such fragmented care transitions are felt most acutely by individuals with complex healthcare needs arising from multiple chronic conditions and/or mental illnesses, since these individuals often require care from a large number of care providers dispersed over multiple care settings.<sup>12,13</sup> Care transitions within this population are of critical importance to the U.S. healthcare system, as over 60 million Americans have multiple chronic conditions, and individuals with chronic conditions account for close to 80% of all healthcare spending.<sup>12</sup>

Suboptimal care transitions often are associated inadequate information transfer and communication between health care locations. We assessed the ability of targeted HIT interventions to serve as facilitators of care transitions in patient populations with complex healthcare needs. Specifically, we assessed the value of two approaches for leveraging HIT to enhance care delivered both within and outside of a patient's medical home. The intent of this combined clinic- and community-based effort was to improve the health of a population, and not just the health of the patients who proactively seek care. Thus, in addition to supporting traditional models of clinic-based care, this project also intervened through managing patients by population and by linking to resources in the community through a HIE network.

## Objectives of Study

This project has been conducted over four years in accordance with four specific aims (Table 1) that explicitly reflect the project’s seven objectives (Table 2).

**Table 1. Original project specific aims**

#	Specific Aim
1	Augment an existing HIE and CDS system by creating new functionality that can detect transitions in care and can conveniently communicate valuable, timely information regarding these care transitions to patients, their primary care clinicians, and members of multidisciplinary care management teams.
2	Implement the new functionality to improve the care of Medicaid beneficiaries with complex healthcare needs and evaluate the impact of the interventions in a three-arm randomized controlled trial. The primary outcome measure will be ED utilization rates. Secondary measures will include hospital readmission rates for the same diagnosis and process measures assessing the appropriateness of follow-up care.
3	Assess the economic impact of the new interventions at both a societal and an individual stakeholder level. The economic evaluation will assess the economic attractiveness of the intervention groups relative to the control group.
4	Disseminate information regarding the development and the impact of the interventions through Web teleconferences, professional meetings, educational lectures, peer review journals and a promotional video. Dissemination to the public will be facilitated through collaboration with the institutional news office.

**Table 2. Project objectives to achieve specific aims**

#	Objective
1	<b>Augment Available Data.</b> Import practice management system scheduling and registration data from additional primary care practices in the NPCCN (Aim 1)
2	<b>Enhance Decision Support System.</b> Demonstrate the ability to detect care transitions and produce care event summary reports in the context of a HIE network (Aim 1)
3	<b>Implement Decision Support for Augmenting Care Transitions.</b> Provide information across care transitions to patients, primary care clinicians, and care managers (Aim 2)
4	<b>Evaluate Clinical Impact of HIT for Enhancing Information Exchange across Care Transitions.</b> Assess the clinical impact of decision support for detecting care transitions and distributing information about care transitions on clinical outcomes (Aim 2)
5	<b>Assess Stakeholder Satisfaction.</b> Determine provider satisfaction with and use of care event summary reports and notices (Aim 2)
6	<b>Evaluate Economic Impact of HIT-Augmented Care Transitions.</b> Assess the economic attractiveness of enhanced information availability across care transitions (Aim 3)
7	<b>Disseminate Results.</b> Disseminate the approaches used in this project as well as the results of the analyses, so as to promote broader use of CDS for augmenting care transitions (Aim 4)

## Context

Patients frequently are passive participants and do not engage directly in their care.<sup>14</sup> However, active patient involvement has been demonstrated to be an effective means for improving health care outcomes.<sup>15-18</sup> Several challenges exist to the provision of such patient-centered care. These include: (1) healthcare and HIT systems built around the hospital or clinic rather than the patient; (2) the inertia of moving away from the traditional approach to healthcare,

in which patients play a largely passive role; and (3) low health literacy among much of the population that limits their healthcare decision-making capacity.<sup>19</sup> This project sought to address these challenges by utilizing health information technology to provide a team-based and patient-centered approach to targeting IOM priority conditions, improving care transitions, and enhancing the care delivered to a vulnerable population.

**Population-based care management.** The North Carolina Department of Medical Assistance has divided the state into 14 care management networks for Medicaid beneficiaries. One of these networks, Northern Piedmont Community Care Network (NPCCN), serves 6 adjoining counties in central and northern North Carolina. Care management services are provided through a community-based care management team that is led by a program manager and includes nurses, social workers, community health workers, nutritionists, and health educators. Approximately 500 individuals are under active care management at any time. Care management services offered through the Network include home assessments, in-home health education and dietary instruction, assistance scheduling and keeping clinic appointments, and support for obtaining and taking medications. Furthermore, these providers routinely interact with other network partners including physicians, nurse practitioners, nurses, and pharmacists.

**Development of a regional HIE.** In an effort to support community-based care management, a regional Health Information Exchange (HIE) network was developed.<sup>20</sup> The COACH system (Community-Oriented Approach to Coordinated Healthcare) was initiated in 2000 as a care management documentation tool. Over the ensuing twelve years, the system has been enhanced to facilitate communication between team members collaborating in the care of patients in the Network.<sup>21</sup> Basic demographic and eligibility data for Network enrollees are uploaded to the system from the North Carolina Office of Rural Health and Community Care on a monthly basis, and data transfer protocols are in place to import clinical and billing data from partner sites. The imported data include encounter and pharmacy claims data from the State Medicaid Office, as well as billing data from nine clinics and all five hospitals in the service region. The four types of data collected by the system include: (1) administrative data (demographics and identifiers, services used, provider associations, audit trails); (2) care management data (care management encounters, health risk and environment assessment, socio-economic data, special needs, and care management plans); (3) clinical data (encounters, problems/procedures, appointments, medications, allergies, laboratory results, disease-specific care plans); and (4) data on communications (messages and alerts, referrals, notices of new information).

**Clinical decision support.** To detect care transitions, we developed a standards-based decision support tool known as CFMCDSS (Community and Family Medicine Clinical Decision Support System) to support sophisticated population health management activities. The system is consistent with the Roadmap for Clinical Decision Support from the Office of the National Coordinator for Health Information Technology.<sup>22,23</sup> CFMCDSS uses Web service technology to receive patient data from a client application. It then processes these data according to an application independent, pre-programmed set of rules (e.g., clinical algorithms and guidelines) and returns back patient-specific recommendations to the client application.

## Settings

This project was conducted within the NPCCN community partnership, which includes healthcare providers serving the Medicaid population across traditional institutional boundaries in a six-county region in North Carolina. This partnership includes 32 ambulatory care practices (including 3 federally qualified health centers and 4 rural health clinics), 3 urgent care facilities, 4 community hospitals, 1 academic medical center, 11 government agencies (county health departments and departments of social services), and two care management teams. The specific partners participating in the Medicaid-focused NPCCN are summarized in Table 3. Twenty-five of the ambulatory care practices participated in the present study.

## Participants

Study participants in this project include Medicaid beneficiaries with complex healthcare conditions who were continuously enrolled in the NPCCN during the intervention period and their care providers. We defined patients with complex healthcare needs as having two or more IOM priority conditions (hypertension, coronary artery disease, congestive heart failure, stroke, asthma, and diabetes) OR a moderate to severe mental health diagnosis (schizophrenic disorder, episodic mood disorder, delusional disorder, non-organic psychoses, anxiety, dissociative-somatoform disorder, and personality disorder) OR chronic renal disease OR end-stage renal disease (ESRD) OR sickle cell disease. Complexity as defined above was determined from ICD-9 billing diagnoses stored in each patient’s record within the COACH HIE.

**Table 3. List of participating study clinic sites at the inception of the project.**

Care Mgt Network	Administrative Group	Billing and Scheduling System	Clinical Site
Durham Community Health Network (DCHN)	Lincoln Community Health Center	Health Pro	Adult Medicine Clinic
Durham Community Health Network (DCHN)	Lincoln Community Health Center	Health Pro	Pediatric Clinic
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Duke Children’s Primary Care
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Duke Family Medicine
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Duke Obstetrics and Gynecology
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Duke Outpatient Clinic (Int. Med.)
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Butner Creedmoor Family Med.
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Durham Pediatrics
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Henderson Family Med. Clinic
Durham Community Health Network (DCHN)	Duke Univ. Health System	IDX	Oxford Family Physicians
Community Care Partners (CCP)	Regional Pediatrics Associates	A4 HealthMatics	Regional Pediatrics

Community Care Partners (CCP)	Henderson Pediatric Center	Misys Tiger®	Henderson Pediatric Center
Community Care Partners (CCP)	Henderson Pediatric Center	Misys Tiger	Granville Pediatric Center
Community Care Partners (CCP)	Beckford Medical Ctr.	NueMD® Practice Mgt	Beckford Medical Center
Community Care Partners (CCP)	Vance Family Medicine	Misys Tiger®	Vance Family Medicine
Community Care Partners (CCP)	North State Medical Ctr.	Practice Partners	North State Medical Ctr.
Community Care Partners (CCP)	VWCHP#	Medical Manager	VWCHP#
Community Care Partners (CCP)	16 Other CCP Sites (with <100 complex pts/site)		

## Methods

### Study Design

This study was a randomized controlled trial evaluating two interventions against a usual care control. This 12-month trial was designed to assess the impact of the intervention on (1) care quality as measured by appropriate utilization of care services and (2) care safety as measured by the performance of recommended follow-up care after a care transition. Medicaid beneficiaries who were continuously enrolled in the NC Community Care Program in NPCCN for at least one year were randomly assigned by family unit to one of three groups. Subjects in Group 1 (Control Group) were maintained with usual care. Subjects in Group 2 (Reports Group) were exposed to an information intervention that consisted of: a Care Event Summary (CES) Report sent to the patient’s assigned medical home following detection of a care transition (Figure 1), a letter mailed to the patient’s home (Figure 2), and a Release of Information (ROI) request sent to the care encounter location on behalf of the patient’s medical home (Figure 3). Subjects assigned to Group 3 (Reports + Group) were exposed to the Group 2 interventions plus an additional intervention consisting of email notifications to their care managers (Figure 4). The study was registered with ClinicalTrials.gov as NCT01039324.

### Interventions

Four types of information were distributed or requested in response to detected care transitions:

**Care event summary reports.** Notices about the occurrence of a hospital discharge, ED encounter, or specialty care visit were faxed or emailed to a patient’s assigned medical home. Reports contained the patient’s name; medical record numbers; demographic and contact information; date(s) of the event; location of the event; the billing diagnoses; the billing procedures; the billing provider; information on up to 12 most recent past appointments; and pending appointments. In addition, a prominent notice was included if a follow-up appointment had not been completed or scheduled at the medical home.



**Patient letters.** Information regarding hospital discharges, ED encounters, and specialty care visits were mailed to the patient, or to the patient's parent/guardian in the case of a minor (notices were not sent for teenagers presenting with selected diagnoses for which privacy is protected by law). These letters contained information similar to that included in the provider care summary reports, with modifications as needed to enhance comprehensibility by lay individuals. The letters also included a list of future scheduled appointments with providers in the COACH HIE. The letters encouraged patients to keep appointments after a care transition event and included a suggestion to bring their medications and the letter itself to the next follow-up appointment. In addition, for patients with events for which the primary diagnosis was one of the 11 most common diagnoses, health education materials pertaining to the condition were included with the letter.


**Release of information requests.** An information release request for relevant data on targeted care encounters (discharge summaries; ED encounter notes; study reports and laboratory test results; and specialty clinic notes) was faxed to the health information management department at the site of the care encounter on behalf of the patient's assigned medical home.

**Care event notices.** Notices about the occurrence of a hospital admission, hospital discharge, ED encounter, or specialty care visit were emailed to a patient's assigned care manager. The email itself did not contain protected health information, but rather a link to a secure, password-protected Web portal where care managers retrieved the care event notices online. The notices contained the patient's name; medical record number; contact information; information on the patient's medical home; date(s) of the event; location of the event; the primary billing diagnosis; and a link to the COACH record to obtain more detailed information on the current encounter as well as past and pending encounters. As with the care event summary reports, there was a prominent notice if a follow-up appointment has not been completed or scheduled at the medical home.

**Figure 1. Sample care event summary report**

<b>Notice of Hospitalization for Lincoln Community Health Center</b>				
<u>Patient Information:</u>				
Name: <b>Smith, Sample P.</b> DOB: 8/17/1943    Age: 64    Gender: M				
Phone #s on file: 919-111-1111 (h); 919-222-2222 (w)				
Address on file: 1234 Maple Street, Roxboro, NC 27573				
MRNs on file: Lincoln (B12345), Durham Regional Hospital (987654321), Medicaid (000000000)				
<u>Hospitalization Information:</u>				
Date: <b>2/1/08 – 2/6/08</b>				
Location: <b>Durham Regional Hospital</b>				
Primary diagnosis: <b>congestive heart failure</b>				
Secondary diagnoses: diabetes mellitus, type II; essential hypertension; obstructive chronic bronchitis				
Procedures performed: right heart catheterization, echocardiogram, chest radiograph, electrocardiogram				
Billing providers: Joshua Maynard, MD				
Request for discharge summary: sent on 2/11/08				
<u>Pending Appointments:</u>				
2/25/08    Duke Cardiology Clinic				
<b>No pending appointment found for Lincoln Community Health Center</b>				
<u>Recent Encounter History (past 12 months or 12 encounters):</u>				
<u>Date:</u>	<u>Type:</u>	<u>Location:</u>	<u>Provider:</u>	<u>Primary Diagnosis:</u>
02/01/08				
12/07/07	Sp	Duke Cardiology Clinic	Elizabeth Smith, MD	congestive heart failure
10/15/07	PCP	Lincoln Comm. Health Ctr.	William Donovan, MD	diabetes mellitus, type II
07/28/07	Sp	Duke Pulmonary Clinic	Terry Sanders, MD	chronic bronchitis
05/02/07	PCP	Lincoln Comm. Health Ctr.	William Donovan, MD	diabetes mellitus, type II
02/19/07	In	Duke Hospital	Donna Sullivan, MD	congestive heart failure
<u>Medicaid-assigned Medical Home Information:</u>				
This patient has also been seen at your practice by the following providers within the last 24 months or last 6 encounters: John Jones (4/26/08), Mary Martin (3/25/08)				

Figure 2. Sample patient letter

<b>Durham Community HealthNetwork</b>	 <b>DUKE OUTPATIENT CLINIC</b> A MEMBER OF DUKE UNIVERSITY MEDICAL CENTER
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September 30, 2010

Dear Mr. John Doe,

We hope you are doing well. Our records show that you were discharged from **Duke University Hospital** on 09/29/2010. Details about that hospitalization are below.

As your Medicaid medical home, we would like to see you after you have a hospital visit. If you have a follow-up appointment with us, it is important that you keep it. If you do not have a visit scheduled with us, please call us at (919) 471-8344.

Here are some appointments you may have scheduled:

10/17/2010 11:30 AM, Duke (Pulm) Stephen Smith (Specialty)  
11/15/2010 3:30 PM, Duke Clinic (2F/G) John Doe (Specialty)

*Please note that this may not be a complete list of all the appointments you have and may not be related to your visit at Duke University Hospital on 09/29/2010. Also if you have already had any of these appointments please ignore this letter.*

When you come for your appointment please remember to bring:

- ✓ **this letter**
- ✓ **your medications**
- ✓ **any papers you were given at the hospital**

We look forward to seeing you soon.

Sincerely,  
*Mary Smith, MD*

Duke Outpatient Clinic  
A Member of the Durham Community Health Network

<b>[Hospitalization/Emergency Department Visit/Specialty Visit] Information:</b> Admission Date: 09/26/10 Discharge Date: 09/29/10 Location: Duke University Hospital Primary diagnosis: asthma Secondary diagnoses: dyspnea Procedures performed: pulmonary function test, nebulizer treatment Billing providers: Stephen R. Smith, MD (Specialty)
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Figure 3. Sample release of information request



	 Lincoln Community Health Center, Inc.
<h3>Release of Information Request</h3>	
<b>TO:</b> Durham Regional Hospital 3643 North Roxboro Street Health Information Management Department Durham, NC 27704	<b>FROM:</b> LINCOLN COMMUNITY HEALTH CENTER 1301 Fayetteville Street Durham, NC 27707 919-956-4000
<b>Patient Information:</b> <b>Name:</b> [REDACTED] <b>DOB:</b> [REDACTED] 1946 <b>Age:</b> 64 <b>Gender:</b> M <b>Record Numbers on file:</b> CA ([REDACTED]), DHS ([REDACTED]), DRH ([REDACTED]), LCHC ([REDACTED]), M-CARE ([REDACTED]) <b>Admission Date:</b> 05/27/2011 <b>Encounter Number:</b> 7233090 <b>Discharge Date:</b> 05/29/2011	
<b>Requested Information:</b> Patient Discharge Summary and Patient Discharge Instructions Radiology Reports Laboratory Reports Other Study Reports	
<b>PLEASE SEND REQUESTED INFORMATION TO:</b> LINCOLN COMMUNITY HEALTH CENTER	

Figure 4. Sample notice sent to a care manager

**COACH Alerts for Ms. Nichole [REDACTED]**  
Document ID: 22639

Reminder: Many of the following recommendations are derived from Medicaid claims data and may have errors because of incomplete or delayed data. If you have any questions or concerns, please contact DCI-Support@notes.duke.edu or (919)684-6421.

Patients requiring attention (highest priority patients listed first):

<b>1.</b> [REDACTED] ( <a href="#">COACH link</a> ). 27 yr. old female, DOB [REDACTED]/84. Medicaid: [REDACTED] NSMC MRN: [REDACTED] PCC: North State Medical Cente [REDACTED] Roxboro, NC 275 [REDACTED]	Priority: 38 Home #: 919-[REDACTED]
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**Complex patient chronic disease management (CDM) issues that may require follow-up:**

**Hospital discharge of a complex patient in the past 14 days:** Location: Person Memorial Hospital. Primary Diagnosis: Not Available. Discharge date: 05/25/2011. Complexity: Complex. Insurance Type: Non-Dual Eligible.

<b>2.</b> [REDACTED] ( <a href="#">COACH link</a> ). 19 yr. old female, DOB [REDACTED]/92. Medicaid: [REDACTED] REGPED MRN: [REDACTED] PCC: Regional Pediatric Associ [REDACTED] Durham, 277 [REDACTED]	Priority: 30 Home #: 919-[REDACTED]
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**Patient chronic disease management (CDM) issues that may require follow-up:**

**Hospital admission of a noncomplex patient in the past 7 days:** Location: Duke Hospital. Primary Diagnosis: Not Available. Admission date: 05/20/2011. Complexity: Non-Complex. Insurance Type: Non-Dual Eligible. Patient has asthma.

## Customization of Interventions Following Initial Deployment

During the course of the study, two decisions were made that altered the original study design with respect to notifications generated and delivered in the three study arms. First, a few study sites realized that the information delivered by this study’s interventions largely duplicated information they already were receiving regarding specific patient care transitions. These sites requested we ‘turn off’ the alerts for those transitions at their sites. More importantly, the State of North Carolina implemented a program to reduce hospital readmissions in an attempt to better manage their Medicare expenditures. The NPCCN decided to focus their program around care manager activities. Care manager protocols occurring during the hospitalization and immediately after discharge were triggered by hospital admission and discharge alerts. NCPPN management also decided to trigger these alerts for straight Medicare patients (not the dual Medicare and Medicaid eligible) in all study arms. This meant that we now had an intervention for the control patients (those receiving usual care). Table 4 depicts the interventions that were triggered and sent or withheld by study arm and insurance status. Cells with a ‘0’ value denote that the intervention would be triggered but not sent to the recipient (care manager, patient, or medical home). Cells with a ‘1’ value denote that the intervention would be triggered and sent to the recipient.

**Table 4. Decision support actions taken**

			Action Taken: Care Manager	Action Taken: Patient	Action Taken: Medical Home	Action Taken: Medical Home
Study Arm	Insurance	Care Type	Alert	Letter	Event Summary	Release of Information
Control	Dual Eligible	ED Visit	0	0	0	0
Control	Dual Eligible	Inpatient Admission	0			
Control	Dual Eligible	Inpatient Discharge	0	0	0	0
Control	Dual Eligible	Specialty Visit		0	0	0
Control	Straight Medicare	ED Visit	0	0	0	0
Control	Straight Medicare	Inpatient Admission	1			
Control	Straight Medicare	Inpatient Discharge	1	0	0	0
Control	Straight Medicare	Specialty Visit		0	0	0
Reports	Dual Eligible	ED Visit	0	1	1	1
Reports	Dual Eligible	Inpatient Admission	0			
Reports	Dual Eligible	Inpatient Discharge	0	1	1	1
Reports	Dual Eligible	Specialty Visit		1	1	1
Reports	Straight Medicare	ED Visit	0	1	1	1
Reports	Straight Medicare	Inpatient Admission	1			
Reports	Straight Medicare	Inpatient Discharge	1	1	1	1
Reports	Straight Medicare	Specialty Visit		1	1	1
Reports +	Dual Eligible	ED Visit	1	1	1	1

			Action Taken: Care Manager	Action Taken: Patient	Action Taken: Medical Home	Action Taken: Medical Home
Reports +	Dual Eligible	Inpatient Admission	1			
Reports +	Dual Eligible	Inpatient Discharge	1	1	1	1
Reports +	Dual Eligible	Specialty Visit		1	1	1
Reports +	Straight Medicare	ED Visit	1	1	1	1
Reports +	Straight Medicare	Inpatient Admission	1			
Reports +	Straight Medicare	Inpatient Discharge	1	1	1	1
Reports +	Straight Medicare	Specialty Visit		1	1	1

Note: 0 = action withheld, 1 = action taken

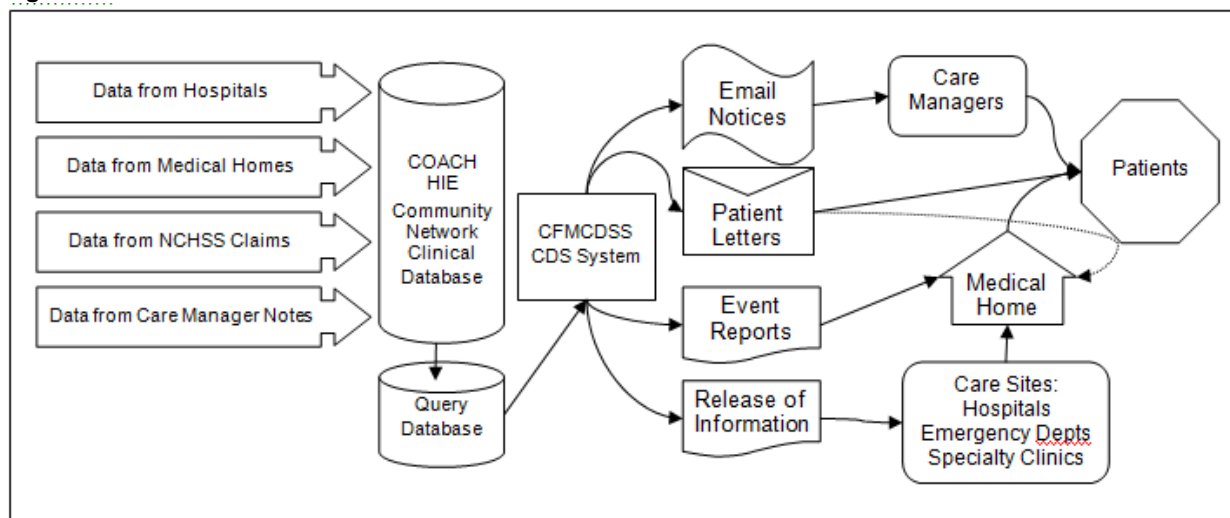
## Data Sources/Collection

Data for the primary and secondary outcomes were obtained via ADT feeds from network hospitals, practice management data from network clinics, and claims data from the NC Department of Health and Human Services. Patient and provider opinions were assessed using validated survey instruments for assessing usability. Figure 5 shows the data flow within the COACH HIE to generate the study interventions. The integrity of the delivery of the CES reports to the study clinic sites was assessed through on-site monitoring visits at study clinics during months 1, 3, 6, and 9. The impact of the intervention on the implementation sites was assessed through a contextual evaluation conducted during the sixth month of the study. Clinical opinions regarding the interventions and their effectiveness were assessed at the completion of the project using validated survey instruments.

## Study Measurements

Important study measurements are shown in Table 5. These included metrics for clinical outcomes, care coordination, medical costs, and patient and provider satisfaction.

**Figure 5. Data flow within COACH HIE**



## Statistical Analysis Methods

All study analyses were conducted by intention to treat. Baseline clinical characteristics are presented as counts with percentages; whereas, study interventions are presented as counts. Differences between treatment groups for baseline characteristics and study interventions were assessed using non-parametric statistical tests. Estimates for study outcomes and between-treatment group comparisons were generated using generalized estimating equation models with a working correlation matrix to account for clustering by primary unit.

**Table 5. Study measures**

Measurement Focus	Measures	Data Sources
<b>Clinical Outcomes.</b> ED encounters Hospitalizations Outpatient encounters	Rate of ED encounters Rate of hospitalizations Rate of outpatient encounters	NC Medicaid claims data Imported encounter data from partner hospitals Imported clinic encounter data from partner clinics
<b>Care Coordination.</b> Follow-up of recommended care after hospitalization	Percent of recommendations deemed appropriate	NC Medicaid claims data Discharge summary audits/recommendation extraction Clinician assessment of recommendation appropriateness
<b>Medical costs.</b> ED costs Hospitalization costs Outpatient costs	Professional fees, technical fees Pharmaceutical reimbursement ED costs, hospitalization and outpatient costs	NC Medicaid claims data
<b>Satisfaction.</b> Patient satisfaction Patient quality of life Provider opinions	CAHPS patient satisfaction survey EQ-5D Health Questionnaire Provider opinion surveys	Telephone calls to patients Provider surveys and interviews

# Results

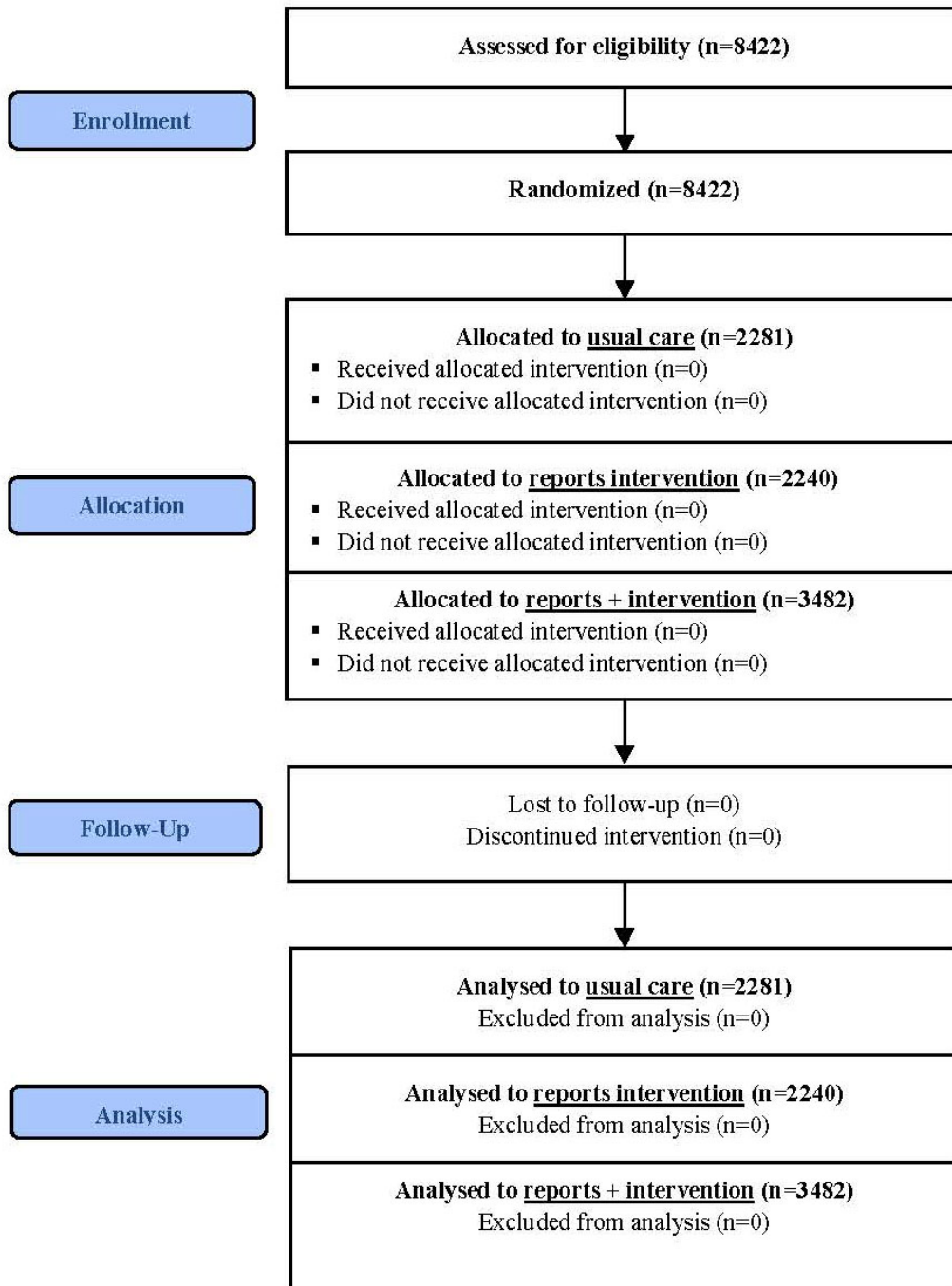
## Study Population

A total of 8422 patients met this study's inclusion criteria. None were excluded for other reasons. Although the intent was to perform a 1:1:1 allocation, the need to focus on hospital readmissions meant that the NCCPN requested a 1:1:2 allocation for straight Medicaid patients and a 1:1:1 allocation for dual eligible patients. As reported in Figure 6, all allocated patients received their assigned interventions, none were lost to follow-up, and all were available for study analyses.

Table 6 shows the final allocation of study subjects by treatment strategy and insurance type. These results are in agreement with the allocation plan and show 2281 patients allocated to the usual care arm, 2240 to patient and medical home directed interventions, and 3482 to patient, medical home, and care manager interventions.



Figure 6. Consort flow diagram



**Table 6. Randomization patterns for 8422 study patients**

Study Arm	Insurance	Patients Enrolled
1	Dual Eligible	431
	Straight Medicare	1850
	Total	2281
2	Dual Eligible	426
	Straight Medicare	1814
	Total	2240
3	Dual Eligible	419
	Straight Medicare	3482
	Total	3901

Baseline characteristics for study subjects are summarized in Table 7 by study arm along with p-values to detect significant differences between each of the intervention groups and the control group. Patients in all study groups were remarkably similar with regard to baseline characteristics. However, the Reports Group had a larger representation of Females and Caucasians and more patients with a history of strokes than Controls. The Reports + Group also had a higher percentage of Caucasians but fewer patients with a history of coronary artery disease than Controls.

**Table 7. Baseline characteristics of subjects randomized for study interventions**

Group	(Control)		Information Intervention Strategies (Reports)			Information Intervention Strategies (Reports+)			Total	
	#	%	#	%	p	#	%	p	#	%
Total	2281	27.1	2240	26.6		3901	46.3		8422	100.0
Gender: Female	1344	58.9	1403	62.6	0.011	2365	60.6	0.19	5112	60.7
Gender: Male	937	41.1	837	37.4		1536	39.4		3310	39.3
Race: Caucasian	451	19.8	515	23.0	0.001	892	22.9	0.008	1858	22.1
Race: Black	1500	65.8	1467	5.5		2502	64.1		5469	65.0
Race: Asian	6	0.1	1	0.0		5	0.1		12	0.1
Race: Native American	11	0.5	3	0.1		6	0.2		20	0.2
Race: Hispanic	21	0.9	28	1.3		44	1.1		93	1.1
Race: Other	119	5.2	92	4.1		200	5.1		11	4.9
Race: Unknown	173	7.6	134	6.0		252	6.5		559	6.6
Age 0 – 2	94	4.1	80	3.6	0.32	173	4.4	0.26	347	4.1
Age 2 -12	505	22.1	463	20.7		896	23.0		1864	22.1
Age 13 -20	432	18.9	448	20.0		802	20.6		1682	20.0
Age 21- 40	431	18.9	424	18.9		792	20.3		1647	19.6
Age 41 -64	623	27.3	624	27.9		1019	26.1		2266	26.9
Age > 64	196	8.6	201	9.0		219	5.6		616	7.3
Condition: Hypertension	825	36.2	843	37.6	0.31	1318	33.8	0.06	2986	35.5
Condition: Coronary artery disease	210	9.2	213	9.5	0.73	298	7.6	0.032	721	8.6
Condition: Congestive heart failure	43	1.9	42	1.9	0.98	68	1.7	0.69	153	1.8

Condition: Stroke	47	2.1	68	3.0	0.037	94	2.4	0.37	209	2.5
Condition: Asthma	175	7.7	147	6.6	0.15	286	7.3	0.62	608	7.2
Condition: Diabetes	411	18.0	416	18.6	0.63	632	16.2	0.07	1459	17.3
Condition: Mental health diagnosis	1050	46.0	1072	47.9	0.22	1836	47.1	0.43	3958	47.0
Condition: Renal disease	24	1.1	23	1.0	0.93	32	0.8	0.35	79	0.9
Condition: Sickle cell disease	18	0.8	23	1.0	0.40	39	1.0	0.40	80	1.0

The number of care event summary reports, patient letters, and release of information requests generated averaged a little less than two per patient in all study groups (Tables 8, 9, and 10). These information interventions were generated for approximately half of the patients in each treatment group, meaning that there were closer to four sets of information interventions generated for each patient with at least one care transition. Per protocol, these information interventions were distributed for patients in the Reports and Reports+ Groups.

**Table 8. Care Event Summary (CES) reports generated**

Group	Arm #1 (Control) #	Arm #2 (Reports) #	Arm #2 (Reports) p	Arm #3 (Reports+) #	Arm #3 (Reports+) p	Total #
CES Reports to Clinics Generated	4464	4456	0.19	7773	0.85	16693
CES Reports to Clinics Distributed	0	4456	<.0001	7773	<.0001	12229

**Table 9. Patient letters generated**

Group	Arm #1 (Control) #	Arm #2 (Reports) #	Arm #2 (Reports) p	Arm #3 (Reports+) #	Arm #3 (Reports+) p	Total #
Letters to Patients Generated	4464	4457	0.19	7773	0.85	16694
Letters to Patients Distributed	0	4059	<.0001	7197	<.0001	11256

**Table 10. Release of Information (ROI) requests generated**

Group	Arm #1 (Control) # Notices	Arm #2 (Reports) # Notices	Arm #2 (Reports) p	Arm #3 (Reports+) #Notices	Arm #3 (Reports+) p	Total #
# ROI Requests Generated	4464	4456	0.19	7773	0.85	16693
# ROI Requests Distributed	0	4456	<.0001	7773	<.0001	12229
# Unique Pts Generating Requests	1144	1167	0.19	1954	0.96	4265
# Unique Pts Distributed Requests	0	1167	<.0001	1954	<.0001	3121

Group	Arm #1 (Control) # Notices	Arm #2 (Reports) # Notices	Arm #2 (Reports) p	Arm #3 (Reports+) #Notices	Arm #3 (Reports+) p	Total #
Avg # Generated Requests / Patient	1.96	1.99	0.78	1.99	0.75	1.98
Avg # Distributed Requests / Patient	0	1.99	<.0001	1.99	<.0001	1.45

Because care manager notices were not generated for specialty visits, the number of these interventions generated per patients was less that for the other interventions (Table 11). Care manager notices generated in the Control and Reports groups were for straight Medicaid patient hospital admissions and discharge.

**Table 11. Care Manager (CM) notices generated**

Group	Arm #1 (Control) # Notices	Arm #2 (Reports) # Notices	Arm #2 (Reports) p	Arm #3 (Reports+) #Notices	Arm #3 (Reports+) p	Total #
# CM Notices Generated	3747	3708	0.29	6174	0.12	13629
# CM Notices Distributed	591	619	0.65	6174	<.0001	7384
# Unique Pts Generating Notices	979	991	0.37	1601	0.15	3571
# Unique Pts Distributed Notices	153	158	0.65	1601	<.0001	1912
Avg # Generated Notices / Patient	1.64	1.66	0.91	1.58	0.58	1.62
Avg # Distributed Notices / Patient	0.26	0.28	0.68	1.58	<.0001	0.88

## Study Outcomes

Care manger contacts may be attributed to this study’s interventions and to other types of alerts that were external to this study. The number of care manager contacts was higher for patients in the Reports + versus the Control Group. Most of this difference was attributable to more frequent telephone call contact (Table 12).

**Table 12. Care manager contacts**

Group	Arm #1 (Control) # Contacts	Arm #2 (Reports) # Contacts	Arm #2 (Reports) p	Arm #3 (Reports+) # Contacts	Arm #3 (Reports+) p	Total Contacts
Total	1.19	1.07	0.53	1.27	0.003	1.19
Home visits	0.27	0.24	0.73	0.29	0.60	0.27
Hospital visits	0.07	0.06	0.20	0.05	0.020	0.06
Phone calls	0.81	0.73	0.94	0.88	0.0005	0.82
Practice encounters	0.02	0.01	0.72	0.01	0.12	0.01
Professional encounters	0.03	0.02	0.84	0.04	0.84	0.03

The number of outpatient, emergency department, and hospitalization encounters was similar for patients in all study groups (Table 13). While there were no treatment-related differences in total medical costs, patients in the Reports + Group had higher pharmaceutical costs than Control Group patients (Table 14).

**Table 13. Encounter rates**

Group	Arm #1 (Control) # Contacts	Arm #2 (Reports) # Contacts	Arm #2 (Reports) p	Arm #3 (Reports+) # Contacts	Arm #3 (Reports+) p	Total Contacts
Outpatient	58.90	55.62	0.75	57.42	0.45	57.35
Emergency Department	1.05	1.09	0.43	1.10	0.82	1.09
Hospitalization	0.22	0.22	0.62	0.22	0.53	0.22

**Table 14. Medical costs**

Group	Arm #1 (Control) \$	Arm #2 (Reports) \$	Arm #2 (Reports) p	Arm #3 (Reports+) \$	Arm #3 (Reports+) p	Total \$
Outpatient	5745	5487	0.34	5914	0.54	5754
Emergency Department	456	497	0.51	503	0.40	489
Hospitalization	1270	1120	0.66	1110	0.68	1156
Pharmaceutical	1999	1994	0.72	2326	<.0001	2149
Total	9469	9099	0.19	9852	0.09	9548

Patient quality of life (using the EQ-5D) and satisfaction with healthcare providers (using the Consumer Assessment of Healthcare Providers and Systems, CAHPS, survey) were evaluated toward the end of the study period in telephone interviews with randomly selected patients. Overall, there was an imbalance in respondents with fewer Reports + and more Reports Group patients included. Respondents to the EQ-5D survey reported no treatment-related differences in quality of life (Table 15). While the typical patient had no problem with self-care, patients did report some problems with mobility, performing usual activities, pain or discomfort, and anxiety or depression. Overall health evaluations for patients were below 70, which is indicative of a chronically ill population with ongoing health issues.

**Table 15. EQ-5D**

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>Mobility</b> I am confined to bed	0	1	0.80	0	0.54	1
<b>Mobility</b> I have no problems walking about	14	35		9		58

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>Mobility</b> I have some problems walking about	20	47		9		76
<b>Self-Care</b> I am unable to wash or dress myself	1	1	0.80	0	0.42	2
<b>Self-Care</b> I have no problems with self-care	25	63		11		99
<b>Self-Care</b> I have some problems washing or dressing myself	8	19		7		34
<b>Usual Activities</b> I am unable to perform my usual activities	3	6	0.68	1	0.46	10
<b>Usual Activities</b> I have no problems with performing my usual activities	11	34		9		54
<b>Usual Activities</b> I have some problems performing my usual activities	20	43		8		71
<b>Pain Or Discomfort</b> I have extreme pain or discomfort	7	24	0.62	5	0.48	36
<b>Pain Or Discomfort</b> I have moderate pain or discomfort	21	44		8		73
<b>Pain Or Discomfort</b> I have no pain or discomfort	6	15		5		26
<b>Anxiety Or Depression</b> I am extremely anxious or depressed	6	11	0.66	6	0.35	23
<b>Anxiety Or Depression</b> I am moderately anxious or depressed	15	44		5		64
<b>Anxiety Or Depression</b> I am not anxious or depressed	13	28		7		48
<b>Overall Health</b>	63.21±22.20	66.73±24.21	0.41	68.75±28.37	0.43	66.08±24.14

The typical adult patient had been in their Medicaid health plan for 5 or more years and had no problem getting a personal health care provider they were happy with and in seeing a specialist when needed (Table 16). Their overall impressions were that their providers were aware of their health care needs and made an extra effort to assure that they received the care they needed. While patients thought they received high quality health care, they also rated their overall health as fair.

**Table 16. Adult survey**

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>How long have you been in this health plan?</b>						
Less than 6 months	1	2	0.76	0	0.28	3
6 months – 1 year	1	3		0		4
1 year to 2 years	2	2		0		4
2 years to 5 years	10	19		2		31
5 or more years	19	59		16		94

Your Personal Doctor Or Nurse

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>Do you have one person you think of as your personal doctor or nurse?</b>						
Yes	26	68	0.78	12	0.48	106
No	7	17		6		30
Rating of personal doctor or nurse (mean±SD)	9.04±1.25	8.75±2.03	0.97	9.58±0.79	0.16	8.91±1.77
<b>How much of a problem to get a personal doctor or nurse you are happy with?</b>						
A big problem	0	2	0.75	0	0.75	2
A small problem	2	8		1		11
Not a problem	24	57		11		92

Getting Healthcare From A Specialist

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>In the last 6 months, did you or a doctor think you needed to see a specialist?</b>						
Yes	22	41	0.16	6	0.055	69
No	11	44		12		67
<b>In the last 6 months, how much of a problem was it to see a specialist that you needed to see?</b>						
A big problem	2	3	0.21	0	0.07	5
A small problem	2	1		1		4
Not a problem	18	37		4		59

Overall Impressions Of Your Health Care

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>Are your providers aware of the care services you need?</b>						
Always	23	54	0.54	12	0.84	89
Usually	4	11		2		17
Sometimes	5	14		4		23
Never	0	3		0		3
<b>Do your providers make an extra effort to assure that you get all the care you need?</b>						
Always	23	52	0.72	11	0.84	86
Usually	6	12		3		21
Sometimes	3	16		3		22
Never	1	2		1		4
<b>Do you receive high quality health care?</b>						
Always	21	52	0.53	12	0.10	85
Usually	7	11		0		18
Sometimes	5	14		6		25
Never	0	5		0		5
<b>In general, how would you rate your overall health now?</b>						
Excellent	3	5	0.56	1	0.95	9
Very good	3	10		2		15
Good	10	21		7		38
Fair	10	37		5		52
Poor	7	9		3		19

Results for child satisfaction with healthcare providers are presented (Table 17). However, they were not analyzed due to the small number of respondents.

Table 17. Child survey

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>How long have you been in this health plan?</b>						
Less than 6 months	0	1	n/a	0	n/a	1
6 months – 1 year	0	0		1		1
1 year to 2 years	0	1		2		3
2 years to 5 years	0	5		2		7
5 or more years	2	22		7		31

Your Personal Doctor Or Nurse

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>Do you have one person you think of as your personal doctor or nurse?</b>						



Yes	1	20	n/a	12	0.48	106
No	1	9		6		30
Rating of personal doctor or nurse (mean±SD)	10.00±0.00	9.50±1.00	n/a	9.58±0.79	0.16	8.91±1.77
<b>How much of a problem to get a personal doctor or nurse you are happy with?</b>						
A big problem	0	0	n/a	0	n/a	2
A small problem	0	0		1		11
Not a problem	1	19		11		92

#### Getting Healthcare From A Specialist

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>In the last 6 months, did you or a doctor think you needed to see a specialist?</b>						
Yes	2	10	n/a	4	n/a	16
No	0	19		8		27
<b>In the last 6 months, how much of a problem was it to see a specialist that you needed to see?</b>						
A big problem	1	1	n/a	0	n/a	2
A small problem	0	0		0		0
Not a problem	1	9		4		14

#### Overall Impressions Of Your Health Care

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
<b>Are your providers aware of the care services you need?</b>						
Always	2	18	n/a	9	n/a	29
Usually	0	8		1		9
Sometimes	0	2		2		4
Never	0	0		0		0
<b>Do your providers make an extra effort to assure that you get all the care you need?</b>						
Always	2	15	n/a	7	n/a	24
Usually	0	8		1		9
Sometimes	0	5		3		8
Never	0	0		1		1
<b>Do you receive high quality health care?</b>						
Always	2	19	n/a	8	n/a	29
Usually	0	6		2		8
Sometimes	0	3		2		5
Never	0	0		0		0
<b>In general, how would you rate your overall health now?</b>						
Excellent	0	12	n/a	4	n/a	16
Very good	0	7		3		10
Good	1	5		3		9
Fair	1	4		2		7

Question Answer	Arm #1 (Control) Responses	Arm #2 (Reports) Responses	Arm #2 (Reports) p	Arm #3 (Reports+) Responses	Arm #3 (Reports+) p	Total Responses
Poor	0	0		0		0

## Care Coordination Evaluations

Three methods were used to evaluate providers and processes involved with implementing this study's information interventions at clinic sites. These included: (1) chart audits, (2) provider satisfaction surveys, and (3) completion of hospital discharge summary recommendations.

**Chart Audits.** This study's project coordinator visited clinics at 1, 3, 6, and 9 months follow-up to monitor the availability of information technology interventions at the point of care. Up to ten charts were audited at each clinic visit to determine if and when the interventions were placed in the charts of complex patients and whether they were available when these patients visited their medical homes. Less than half of the sites were audited at 1 and 3 months; whereas, 24 sites were audited at 6 and 9 months. Overall the percent of information interventions found in charts was 60% and did not vary appreciably between audit periods. However, the percent of information interventions that were available varied by site suggesting that some sites were able to quickly integrate this information into their workflow while other sites were not.

**Table 18: Chart audits and provider satisfaction results**

Clinic Site	Total Patients		Percent Interventions in Audited Patient Records					Provider Satisfaction Results			
	Audited	In Chart	1-Mo	3-Mo	6-Mo	9-Mo	Total	1-Mo	3-Mo	6-Mo	9-Mo
Beckford-Henderson	40	25	30	90	90	40	63		5	5	5
Duke Outpatient	27	0	0		0	0	0	1			
Four County Primary	36	25	80	90	50	50	69	4	5	5	4
Lincoln – Pediatric	30	0	0		0	0	0			3	1
NC Pediatric	35	28	60	100	70	100	80				4
North State Med Center	35	25	0	90	100	60	71		5	5	5
William B Olds	22	13	60		71	50	59	4		5	5
Premier Women's	35	14	78	67	30	0	40	4	5	2	3
Regional Pediatric	20	16	70	87	100		80			1	2
Roxboro Family Med	37	25	71	50	80	70	68	5	5	3	5
Roxboro Internal Med	37	28	86	80	60	80	76	5		5	4
Rural Health Group	40	35	90	80	100	80	87	5	5	4	4
Sundar Int Med Assoc	23	23	100		100	100	100	5		5	4
DUAP Henderson	30	17		10	80	80	57				2
Roxboro Medical	18	9		17	60	71	50			3	4
Vance Family Medicine	30	25		90	60	100	83		5		
Amarika	8	8			100	100	100			5	5
BMC	6	0			0	0	0			1	2
DMF	18	13			90	50	72				
Duke Peds	10	7			50	100	70			2	3
DUAP – Butner	9	0					0	0			4

FCHD	15	11			100	50	73				4
GFM	17	0			0	0	0			2	
Mahan	11	1			0	100	9			2	5
William A. Sayles	20	16			80	80	80			5	4
Total	609	364	55	71	61	55	60				

**Provider assessments.** Providers at clinic sites were asked to evaluate the utility of this study’s information interventions on a scale of 1-5. While most of the evaluations were favorable (4 or 5), a number of sites replied ‘NA’ to this question or did not return their surveys. Of note, it appears that providers at sites for which information interventions were more frequently in patient charts tended to respond more favorably in their evaluations.

**Care coordination and safety.** In order to evaluate the impact of this study’s information interventions on care coordination and safety, we assessed the rate at which tests or procedures recommended in hospital discharge summaries were completed following discharge. For this assessment, we randomly selected 600 hospitalizations from which post-discharge care recommendations were abstracted. A total of 156 procedures were recommended for 87 patients (1.8 per patient) in the 600 hospitalizations. After discharge, 107 (69%) of recommended procedures were completed. Two physicians performed independent records reviews for the 87 patients with recommended procedures. These physicians rated 32% of the recommended procedures as necessary and 68% as not necessary.

## Limitations

The findings of this study need to be interpreted in the context of this study’s setting. This study focused exclusively on care transitions for patients with one or more complex health condition who were enrolled in a Medicaid health network. Accordingly, the study findings may not necessarily be generalizable to other populations. Our initial plan was to use a 1:1:1 allocation ratio with pre-specified sets of information interventions for each study arms. However, our study design was altered due to external financial pressures from the North Carolina Medicaid program. Hence our study as implemented did not have the statistical power to detect treatment-related differences that was planned when the study proposal was submitted. While we think it is unlikely that these differences were the sole factors contributing to our negative findings, they undoubtedly had some influence in that direction. A second limitation was the methods chosen to deliver our study’s information interventions to clinic sites. If the hospitals and clinics participating in this study all shared an electronic health record system, information regarding patient transitions would have been available at the time a patient visited their medical home provider. As it was, this information was transmitted by fax or email and was only available for 60% of the cases reviewed. The inability to consistently deliver our information interventions also may have impacted our study results.

## Dissemination

The development, methodology and findings from this study have been disseminated through a variety of mechanisms described in the List of Publications and Products at the end of this report. Additionally, we plan to submit a manuscript describing our study’s results to a peer reviewed publication.

## **Discussion**

In this randomized controlled trial, we demonstrated that selected types of clinical decision support are able to successfully detect care transitions for complex patients and enable information interventions targeted to specific entities responsible for the care of those patients. Although the letters to patients and email notices to care managers were delivered successfully, our clinic site audits found that only 60% of the information directed to patient providers was available and in patient charts when follow-up visits for complex patients occurred. Hence, the most important information for managing care transitions was frequently missing and not available to the medical home provider for consideration in their decision-making. Despite the fact that our research team performed workflow analyses for each study site, it appears that the integration of new information into existing workflows remained a problem for a significant number of study sites. Future studies in this area will need to pay particular attention to sociotechnical issues to enable better delivery of information interventions.

## **Significance**

This study demonstrates technical advancements in CDS for detecting care transitions and providing timely and actionable information at both the clinic and the population levels. Our system is integrated into a regional HIE that permits the seamless integration of care transition information into the normal processes of our regional health network. The successful implementation of the study interventions demonstrates that the management of healthcare for a population is feasible through a regional health information exchange primarily populated with Medicaid patients. These findings provide evidence that decision support-enabled population health management may be an effective approach for addressing the health needs of patients outside of traditional clinic-based models of care. Nonetheless, our study's inability to detect changes in clinical and economic endpoints is problematic. Whether this was due to workflow-related implementation issues or the lack of effective means for providers to change patient behavior so as to minimize readmissions is not known. However, we believe that future studies of this type should focus greater attention on clinic site activities to assure that their information interventions are effectively integrated into busy clinic workflows and practices and to assure that providers have effective means for changing patient behavior.

## **Conclusions and Implications**

In this project, we have developed and implemented an approach for proactive population-oriented health care management using standards-based decision support in the context of a regional health information exchange for Medicaid beneficiaries. Through this system, we have demonstrated that we can detect important care needs of a population without requiring patients to have clinic-based encounters. Specifically, we detected emergency department, hospital, and specialty visit transitions for patients with complex health conditions. While we effectively generated our information interventions, their delivery in certain clinic settings was problematic and they collectively had no measurable effect upon our primary study endpoints. We believe that these results highlight the importance of effectively integrating information systems and interventions into existing sociotechnical systems at the locations healthcare is delivered.

## AHRQ Priority Population

This study addressed care transition issues for a lower income (Medicaid beneficiaries), minority (65% African American) population residing in both rural and urban settings in the north and central Piedmont region of North Carolina. Subjects in this study presented with complex healthcare needs as defined by IOM priority conditions (hypertension, coronary artery disease, congestive heart failure, stroke, asthma, and diabetes) OR a moderate to severe mental health diagnosis (schizophrenic disorder, episodic mood disorder, delusional disorder, non-organic psychoses, anxiety, dissociative-somatoform disorder, and personality disorder) OR chronic renal disease OR end-stage renal disease (ESRD) OR sickle cell disease.

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## List of Publications and Products

### Published Works and Electronic Resources from Study

1. We completed a video describing the Complex Patient project.
2. One or more peer-reviewed publications will be submitted later this year.

### Panels and Invited Presentations

#### International / National

1. November 18, 2008: Dr. Lobach co-presented an AHRQ webinar "How CDS Can be Used to Monitor or Improve Population Health" and included a discussion on the methodological design and objectives of this grant.
2. January 15, 2009: Dr. Lobach was the invited external speaker at the third quarterly meeting of the CDS Government Collaboratory in Rockville, Maryland. Dr. Lobach's presentation described decision support resources for supporting new models of healthcare including examples from this chronic disease management project.
3. April 16, 2009; Dr. Lobach was a visiting professor with the NYC Department of Health and Dental Hygiene where he presented information about this project.
4. January 27, 2010: Dr. Lobach presented "Dealing with the IRB for Health Information Technology Evaluation Trials: Real World Experience" - Presentation to AHRQ Grantees via Web-Ex

#### State / Regional

1. October 6, 2009: Dr. Lobach presented "HIT Value Evaluation of Care Alerts" Presentation to Directors of all State Medicaid Care Management Teams at the Community Care of NC, Clinical & Network Directors Meeting
2. October 6, 2010: Dr. Lobach was a guest speaker at the University of North Carolina Conference on Telehealth where he presented, "Health Information Technology for Enabling New Models of Care" and described this project in detail.

#### Local

1. September 9, 2009: Dr. Lobach presented "HIT to Support New Models of Care: Clinical & Economic Results" to the Leaders of State Medicaid at Durham Regional Hospital

2. October 14, 2009 Dr. Lobach presented “HIT Value Evaluation of Care Alerts” to the Leaders of Duke Community Engagement

3. December 7, 2009: Dr. Lobach presented “Health Information Technology for Enabling New Models of Care” to the leaders in Duke Primary care at the Community of Family Medicine Conference