

Grant Final Report

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**Technology for Optimizing Population Care in a
Resource-limited Environment (TopCare)**

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Structured Abstract

Purpose: To develop and evaluate a health information technology (HIT) enabled, visit-independent, population management system within a primary care (PC) network for preventive cancer screening.

Scope: Advanced HIT now permits population-based screening, but the best methods remain uncertain. We compared two versions of a HIT system: one in which PC providers (PCPs) screened patients and one that did not. We hypothesized that involving PCPs would lead to more effective and efficient screening.

Methods: Cluster practice-randomized controlled trial of 18 practices within an academic PC network with 103,870 adults eligible for breast, cervical, and/or colorectal cancer screening. In intervention practices, PCPs screened real-time rosters of their patients overdue for screening, and could individualize contact (letter, practice delegate or patient navigator) or defer screening. In control practices, overdue patients were automatically sent reminder letters and transferred to a practice delegate for follow-up. Intervention patients without PCP action within 8 weeks defaulted to the automated control version. Adjusted average cancer screening completion rates over 1-year were compared between intervention and control practices.

Results: Most intervention providers used the tool (88 of 101, 87%) and reviewed 7984 patients overdue for at least 1 cancer screening (including 21% deferred from screening). A total of 12,002 letters were sent to patients in intervention practices versus 16,378 letters in control practices ($p < 0.001$). Screening rates did not differ among intervention and control practices for all cancers combined (81.6% vs. 81.4%, $p = 0.84$), breast (82.7% vs. 82.7%, $p = 0.96$), cervical (84.1% vs. 84.7%, $p = 0.60$), or colorectal cancer (77.8% vs. 76.2%, $p = 0.33$).

Key Words: screening; population management; health information technology; HIT

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Final Report

Purpose

The original grant application had the following specific aims:

Specific Aim 1: To design, develop, and implement a novel cancer screening intervention program called Technology for Optimizing Population Care in A Resource-limited Environment (TopCare) that facilitates the identification, individualized contact, and subsequent tracking of patients overdue for screening.

Specific Aim 2: To conduct a practice randomized trial of the TopCare program within a primary care practice based research network (PBRN) assessing its impact on cancer screening rates in eligible patients.

Specific Aim 3: To prospectively collect data during the randomized trial about the costs, preferences, and clinical and process outcomes to inform a subsequent formal cost-benefit analysis.

This research is relevant to nationwide efforts, such as the patient-centered medical home, to rigorously demonstrate the most effective and efficient ways to implement novel health information technology (HIT)-based health delivery models to provide high quality population-based primary care within resource-limited health care settings.

Scope

Background

Our current health care system is costly, inefficient, fragmented, and unsafe. Advances in HIT; organized efforts to measure and improve health care quality; the need to control relentlessly increasing costs; and the increasing number of Americans without adequate health insurance are all factors driving the need to re-engineer our current system of primary care. Successfully modernizing our current system will require the effective implementation of innovative HIT systems that enable greater care coordination and population-level oversight. We envision a system of primary care in which providers can 1) review all relevant data for the entire panel of patients under their care and 2) use “one-click” ordering to initiate a cascade of downstream clinical actions to optimize care. This new model of care emphasizes management outside of the traditional one-on-one clinic visit and also provides a framework to facilitate the efficient allocation of limited clinical resources.

Although there is considerable evidence that current HIT can improve certain elements of care, the most effective and efficient implementation of HIT systems for primary care population management are not currently known.

Context

Prior research done by our group has demonstrated that a HIT system utilized by physicians can increase cancer screening rates for a single condition (Mammography FastTrack, NCI 1R21CA121908). This study compared a non-visit based HIT-enabled population management system for women overdue for preventive breast cancer screening to usual care. In a cluster randomized controlled trial, twelve practices were randomly assigned to intervention (n=6) or control (n=6) groups. In intervention practices, a population-based informatics system was implemented that: connected overdue patients to appropriate care providers, presented providers with a Web-based list of their overdue patients in a non-visit based setting, and enabled “one-click” mammography ordering or documented deferral reasons. Patients selected for mammography received automatically-generated letters and follow-up phone calls. Follow-up after 1-2 years showed mammography rates were significantly higher in women overdue for screening in intervention group practices (Atlas et al, J Gen Intern Med 2011; Atlas et al, Am J Manag Care 2012).

Some have advocated that non-visit based reminder systems can bypass clinicians and automatically contact patients overdue for “routine” health maintenance and screening processes. Research to clarify the relative value of clinician input can help with the appropriate design of future population health management delivery systems. We designed, developed, and implemented a novel HIT system for comprehensive cancer screening (breast, cervical and/or colorectal) that compared involving PCPs in the screening process to customize patient outreach versus a fully automated process. We hypothesized that having PCPs determine whether contact was needed, and if needed how best to provide it, would lead to more effective and efficient cancer screening.

Setting

The Massachusetts General Primary Care Practice-Based Research Network includes 18 adult primary care practice sites, and utilizes electronic health records with information about preventive cancer screening tests available during clinical encounters.

Participants

Eligible patients had at least one visit to a study practice within the prior 3 years or during the 1-year study period and were connected with a specific network physician or practice. Patients eligible for breast, cervical and/or colorectal cancer screening included: women 42 to 74 years of age who had not undergone bilateral mastectomy, women 21 to 64 years of age who had not undergone total hysterectomy, and men or women 52 to 75 years of age who had not undergone total colectomy, respectively. Patients were considered overdue for screening if eligible for breast cancer screening with no record of having a mammogram in the past two years, eligible for cervical cancer screening with no record of having a Pap smear in the past three years, and/or

eligible for colorectal cancer screening with no record of having a colonoscopy in the past ten years, or sigmoidoscopy, barium enema, or CT colonography in the past five years.

Methods

Study Design

Development of the TopCare HIT system involved creating a generic system architecture, an automated system, and an intervention system (Specific Aim 1). The generic architecture involved a robust security layer to control access for the application, a permission mechanism so only one user could access a particular patient at a time, an interface system to connect to external services (such as a letter component to automate the generation and mailing of patient letters by the United States Postal Service), and integration of our patient linkage methodology which links patients to a specific PCP or practice in a real-time operational process (Atlas et al, *Annals Intern Med* 2009). The automated operational system involved creating real-time data services for breast, cervical, and colorectal cancer to feed the application, developing the process to load outpatient encounters, designing the user interface and the functionalities to allow users to interact with the system, and creating a natural language processing methodology to abstract relevant data from the electronic health record to present to users of the system. Additionally, we developed an intervention system which allowed providers from intervention practices to choose how patients were contacted and whether or not they were contacted at all.

Development and testing of the TopCare HIT system required collaboration with practices and leadership within our network as well as getting feedback from focus groups of system users, including primary care physicians, population managers, practice contact delegates, patient navigators, and central administrative personnel. Quality control testing was conducted by 6 grant investigators/staff members, usability testing was conducted in a pilot site prior to releasing to our study practices, and all users of the system received group or individual training prior to the launch of the application. The application was released to production on June 15th, 2011. Improvements continued to be made to the application based on user feedback we received after the launch (Specific Aim 1). The 1-year randomized trial was from June 15, 2011 – June 14, 2012 (Specific Aim 2). Practice sites were randomly assigned to intervention (n=9) or control (n=9) groups. To minimize imbalance between groups, practices were first stratified by practice type (health center or non-health center). Within each type, practice pairs were matched by prior year baseline screening rates for all cancers, unaffiliated outside facility cancer screening rates, total number of eligible patients, gender proportion of patient panel, and proportion of patients linked with a specific physician. Practices within each pair were then randomly allocated to intervention versus control arms.

Control arm (augmented usual care): Control group practices used an automated version of the application without provider review. The automated application performed three basic functions: 1) it identified all patients overdue for breast, cervical, and/or colorectal cancer screening in real-time and mailed them customized reminder letters (English or Spanish) with informational handouts; 2) it transferred them to a practice delegate who could use the application to assist with scheduling tests; and 3) it tracked testing so that only patients with

unscheduled tests were displayed. In addition, patients remaining on delegate lists for at least 4 months who were identified as being at increased risk for screening non-adherence (using an electronic algorithm employing patient age, non-English speaking, number of overdue tests and no-show visits) were automatically transferred to a central patient navigator list for further outreach.

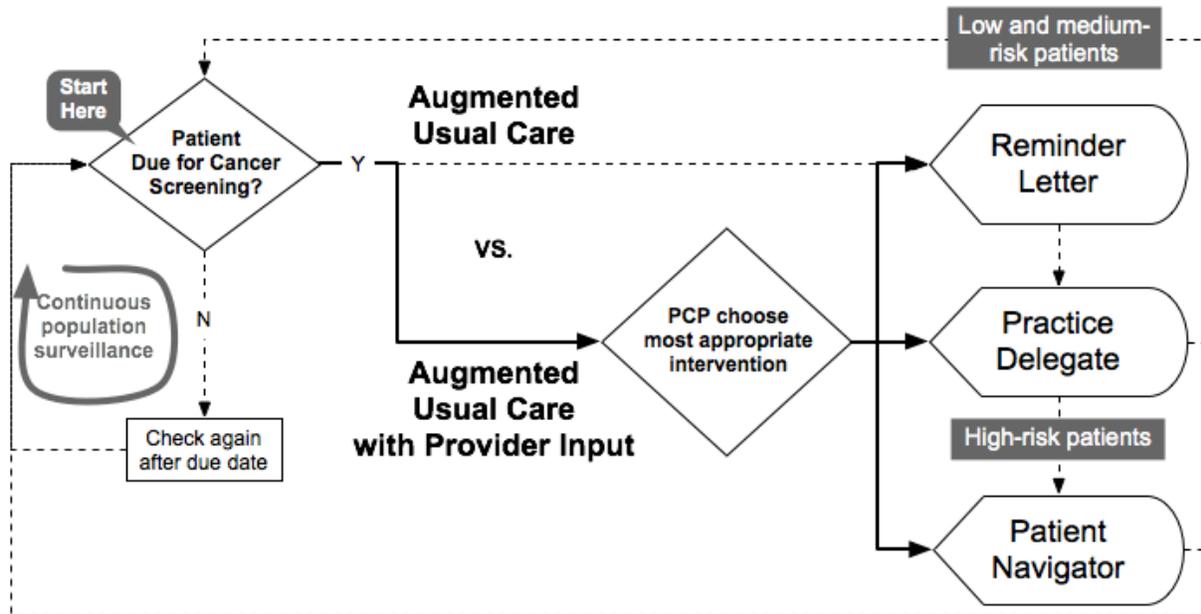
Intervention arm (augmented usual care with provider input): Intervention practices used the same system, except that providers could customize individual patient outreach. Physicians, for their own patients, or population managers, for patients not linked to a physician, used the application to screen a list of his/her overdue patients. This roster was updated daily and was accessed via monthly email reminders to users or any time via links within the electronic health record. The provider roster included (see Figure 1): 1) patient identifiers, 2) eligible cancer screening test(s) and screening status (to be listed when at least one was overdue), 3) clinically relevant decision support to help providers decide whether or not to initiate patient contact, and 4) an actionable component which allowed the provider to mail a reminder letter, directly transfer to a practice delegate for prioritized outreach, directly transfer to a patient navigator for intensive outreach, or defer screening temporarily or permanently. Patients were mailed a letter automatically if the provider performed no action within 8 weeks.

The workflow of intervention and control groups is depicted in Figure 2.

Figure 1. Screenshot of a provider’s roster of overdue patients. It shows the specific actions available for a patient, as well as whether the patient is eligible for a specific cancer screening test and whether it is up-to-date or not. At the far right, are the number of days remaining, telling the provider when the automated system will take over. By clicking on an unscheduled test, the provider is taken to a web page that provides additional information and options.

Select	Name	MRN	PCP	Next PCP Appt	Breast	Cervical	Colorectal	Risk	Days Left
<input type="checkbox"/>				no appt	scheduled	excluded	unscheduled	Moderate	5
<input type="checkbox"/>				no appt	uptodate	excluded	unscheduled	Low	5
<input type="checkbox"/>				no appt	excluded	unscheduled	excluded	Low	14
<input type="checkbox"/>				no appt			unscheduled	Low	16
<input type="checkbox"/>				no appt	excluded	unscheduled	excluded	Low	24
<input type="checkbox"/>				no appt	uptodate	unscheduled	uptodate	Low	38
<input type="checkbox"/>				no appt	excluded	unscheduled	excluded	Low	43
<input type="checkbox"/>				no appt	unscheduled	excluded	unscheduled	Moderate	43
<input type="checkbox"/>				no appt	unscheduled	uptodate	excluded	Low	51
<input type="checkbox"/>				12/09/2011			unscheduled	Low	56

Figure 2. Diagram depicting the workflow of intervention and control groups. Augmented usual care with provider input (intervention), solid lines; augmented usual care without provider input (control), dotted lines.



Practice delegates. Practice delegates were either administrative staff or medical assistants, and were available to facilitate follow-up among overdue patients in both intervention and control practices. Patients appeared on delegate lists after being sent a reminder letter or after a provider from an intervention practice directly referred them. Letters included a practice phone number so patients could call the delegate directly and request assistance with scheduling. Delegates could also use the list to make outgoing calls to patients, and those in intervention practices were trained to give priority to patients referred directly by providers. Patients who scheduled or completed all overdue tests were automatically removed from delegate lists, but patients who missed scheduled screening appointments were added back. After 4-months, patients still overdue were transferred to a patient navigator list if a decision support algorithm identified them as at high risk for screening non-adherence. All other patients were removed from the active system for the remainder of the year.

Patient navigators. The ability to navigate patients referred by intervention providers or from the risk algorithm for screening non-adherence for all sites began in October, 2011 using a full-time trilingual (English, Spanish, Portuguese) patient navigator. Other existing navigator and interpreter resources were used to help navigate patients speaking 18 other languages. Patient navigators contacted patients on their roster, explored individual barriers, and tailored interventions to help complete screenings. Patients remained on the navigator roster until all overdue tests were completed, or the patient navigator selected an appropriate deferral or exclusion reason.

Data Sources

Patient characteristics and cancer screening data were obtained from an electronic central data repository at Partners Healthcare. Dates of screening exams were obtained from electronic reports or billing data. The informatics application collected information on usage by providers, delegates, and patient navigators.

In addition, supplemental funding for a companion economic analysis of TopCare was funded by AHRQ (Levy, PI, R03 HS020308). To prospectively collect data required for formal cost analyses, we first identified the variables necessary for cost analyses. A survey instrument was developed for variables not available from other sources. Baseline and follow-up surveys assessing time spent doing cancer screening tasks and satisfaction with the system (follow-up only) was administered to physicians and practice delegates. Overall, 123/165 (75%) of PCPs and 41/47 (87%) of practice delegates completed the baseline survey. For the follow-up survey, 87/165 (53%) of PCPs and 15/47 (32%) of delegates completed the follow-up survey. Direct observations with the main patient navigator, a practice population manager, a delegate, and three PCPs were completed to estimate the time spent going through lists. Additionally, we asked PCPs and practice population managers to time themselves going through their lists and report back via email. We received feedback from 16 PCPs and 2 practice population managers reporting how many patients they reviewed and the amount of time it took them (Specific Aim 3).

Measures

The primary outcome was the overall cancer screening test completion rate over the 1-year follow-up period for each eligible patient with all eligible cancers combined. For example, a patient who was eligible for a total of 3 screening tests at a given time, the completion rate could be 0% (none of the 3 tests completed), 33%, 67% or 100% (all 3 tests completed). Similarly, the completion rate could be 0%, 50%, or 100% if patients were eligible for 2 screening tests at a given time. By assessing the completion rate over the 1-year follow-up period for each patient, the average completion rate over time was estimated from the area under the curve.

We also calculated the completion rate for each individual cancer as the percentage of time screening was up-to-date among eligible patients during follow-up. Secondary outcomes included comparisons of average cancer screening test completion in specified subgroups including individuals newly overdue for screening during the 1-year study period, and cancer screening rates over time. Other outcomes included measures of system usage.

Statistical Analyses

We compared patient and physician/practice characteristics between intervention and control groups using two-sample t-tests or chi-square tests, as appropriate. For primary and secondary outcomes, a mixed effects model was used to compare the average completion rate between patients from intervention practices and patients from control practices for all cancer screening exams combined, and for each individual screening exam while taking into account clustering by PCP or practice (PROC MIXED, SAS version 9.2, SAS Institute, Cary, NC). The physician was considered as the unit of cluster for patients connected with a specific PCP, and the practice was

considered the unit of cluster for patients who could be connected with a practice, but not a specific PCP.

To control for differences in patients and practice characteristics among intervention and control practices, age, ethnicity, insurance status, primary language, time since last practice visit, and gender (for all cancer screenings combined, and colorectal cancer screening) were included in the models as covariates. We compared the primary outcomes in intervention and control practices within relevant subgroups and calculated adjusted rate differences and 95% confidence intervals. Patient subgroups were defined by age, number of overdue tests in women, race/ethnicity, English language proficiency and insurance status. Physician/system subgroups included patient-provider linkage status, practice site (health center or not), and engagement of intervention site by providers and delegates.

Results

Principal Findings

Practice, physician and patient characteristics. Practice, physician, and patient characteristics are shown in Table 1. Three community health center sites were in each study arm. There were 92 physicians in the 9 intervention arm practices and 77 physicians in the 9 control arm practices. Intervention physicians were slightly more experienced, but differences were not statistically significant. A total of 103,870 patients were eligible for at least 1 cancer screening during the 1-year study period (intervention group: 51,071, control group: 52,799). Patients in intervention practices were slightly older, and slightly more likely to be male, non-Hispanic white, speak English, to have a primary care visit within the last 6 months, to be connected to a specific PCP, and to have Medicare insurance (all p-values <0.001). Intervention patients were slightly less likely to have commercial insurance and to be seen in a community health center (p-values <0.001).

Use of the Population Management IT System. All intervention population managers (9 of 9, 100%) and 79 of 92 intervention physicians (85.9%) used the HIT system during the study period. A total of 16,573 patients who appeared overdue for at least one cancer screening test were sent to intervention provider rosters over the study period. Providers reviewed and took action on 7984 (48.2%) patients (5874 [73.6%] selected to receive a reminder letter, 401 [5.0%] referred directly to a scheduling delegate, 47 [0.6%] referred directly to a patient navigator, 1551 [19.4%] deferred temporarily, and 111 [1.4%] excluded permanently). Among intervention patients for whom no action was taken by their provider, 6128 (37.0%) were sent automated reminder letters, 1764 (10.6%) no longer overdue were removed by the system prior to a letter being mailed, and 697 (4.2%) patients remained on provider rosters at the end of the study period. In control practices, 16,378 patient letters were mailed without provider review (31.0% [16,378/52,799] of eligible patients) compared to a total of 12,002 letters in intervention practices (23.5% [12,002/51,071] of eligible patients, p-value <0.001). Practice delegates documented actions taken (calls, deferrals, and exclusions) for 4.7% of patients on their rosters. Intervention delegates documented actions in 6.6% of patients (range by practice: 0% - 28.0%) and control delegates documented actions in 3.4% of patients (range by practice: 0.2% - 8.2%).

Table 1. Practice, Physician and Patient Characteristics among Intervention and Control Practices

	Intervention (n=51,071)	Control (n=52,799)	P-Value
Practice/physician characteristics, n			
Number of practice sites	9	9	
Community health center	3	3	
Number of physicians (median per practice)	92 (9)	77 (9)	
Age, mean (SD)	49.7 (10.1)	47.5 (10.0)	0.14
Gender, n (%)	50 (54.4%)	45 (58.4%)	0.59
Years since medical school graduation, mean (SD)	21.8 (10.4)	19.6 (10.1)	0.15
Years in primary care network, mean (SD)	15.8 (10.9)	13.1 (10.4)	0.09
Patient characteristics, n (%)			
Age, mean (SD)	51.5 (14.3)	48.5 (14.8)	<0.001
Gender, female	37,906 (74.2%)	40,568 (76.8%)	<0.001
Ethnicity			<0.001
African-American	2920 (5.7%)	3319 (6.3%)	
Asian	2724 (5.3%)	3473 (6.6%)	
Hispanic	3865 (7.6%)	5964 (11.3%)	
Other/unknown	1256 (2.5%)	1384 (2.6%)	
Non-Hispanic white	40,306 (78.9%)	38,659 (73.2%)	
Insurance status			<0.001
Commercial	35,665 (69.8%)	37,895 (71.8%)	
Medicaid	4602 (9.0%)	5486 (10.4%)	
Medicare	9058 (17.7%)	7437 (14.1%)	
No insurance, self-pay/free	1746 (3.4%)	1981 (3.8%)	
Primary language spoken, English	46,560 (91.2%)	46,478 (88.0%)	<0.001
Patient-physician connectedness status			<0.001
Physician-Connected	42,449 (83.1%)	42,132 (79.8%)	
Practice-Connected	8622 (16.9%)	10,667 (20.2%)	
Time since last practice visit			<0.001
< 6 months	31,439 (61.6%)	30,658 (58.1%)	
6 – 12 months	10,206 (20.0%)	10,473 (19.8%)	
> 1 year	6668 (13.1%)	8663 (16.4%)	
New patient	2758 (5.4%)	3005 (5.7%)	
Practice Type, Community health center	7008 (13.7%)	8935 (16.9%)	<0.001

Primary outcomes: cancer screening rates at study completion. Among patients eligible for cancer screening, unadjusted and adjusted average cancer screening completion rates were similar (Table 2). There was no difference in adjusted average cancer screening test completion rates between intervention and control groups for all cancers combined (Intervention: 81.6%, Control: 81.4%, $p=0.84$), breast cancer screening (Intervention: 82.7%, Control: 82.7%, $p=0.96$), cervical cancer screening (Intervention: 84.1%, Control: 84.7%, $p=0.60$), or colorectal cancer screening (Intervention: 77.8%, Control: 76.2%, $p=0.33$).

Table 2. Cancer Screening Rates Among Intervention and Control Patients Eligible for at Least 1 Cancer Screening Test During the Study Period

	Unadjusted Average Cancer Screening Test Completion Rates					Adjusted* Average Cancer Screening Test Completion Rates		
	Inter- vention Number	Inter- vention Rate	Control Number	Control Rate	P-value	Inter- vention Rate	Control Rate	P-value
All patients								
All eligible cancers	51,071	81.6%	52,799	81.4%	0.90	81.6%	81.4%	0.84
Breast	24,602	82.8%	22,351	82.7%	0.93	82.7%	82.7%	0.96
Cervical	32,121	84.2%	35,889	84.7%	0.72	84.1%	84.7%	0.60
Colorectal	30,353	77.9%	26,756	76.2%	0.33	77.8%	76.2%	0.33

* Adjusted rates and p-values obtained from mixed effects models comparing intervention and control groups controlling for patient age, ethnicity, insurance status, primary language, time since last practice visit, patient-physician linkage, and gender (for colorectal cancer and all screenings combined) while accounting for clustering by primary care physician or practice in a mixed effects model.

Secondary outcomes and subgroup analyses. Among patients who appeared overdue for at least one cancer screening test during the study period, unadjusted and adjusted average cancer screening completion rates were similar in intervention and control groups (Table 3). Because documented use of the IT system by practice delegates was low, we examined outcomes in practices where delegate use was higher since their involvement was hypothesized to have more impact in intervention practices. Among practices in the top tertile of IT system use by delegates, intervention patients had higher adjusted average cancer screening test completion rates for all cancers combined ($p < 0.001$), breast cancer screening ($p = 0.06$), cervical cancer screening ($p < 0.001$), but not colorectal cancer screening ($p = 0.79$) (Table 3). However, overdue patients of intervention providers in the top tertile of IT system use did not have higher screening rates than overdue patients from control practices unless those intervention PCPs were also associated with higher rates of IT system use by delegates (data not shown).

Table 3a. Cancer Screening Rates among Eligible Intervention and Control Patients Overdue for at Least 1 Cancer Screening Test During the Study Period

	Unadjusted Average Cancer Screening Test Completion Rates					Adjusted* Average Cancer Screening Test Completion Rates		
	Inter- vention Number	Inter- vention Rate	Control Number	Control Rate	P-value	Inter- vention Rate	Control Rate	P-value
All overdue patients								
All eligible cancers	18,873	18.3%	19,201	17.8%	0.59	18.8%	17.8%	0.28
Breast	6927	23.2%	6486	24.0%	0.52	23.7%	24.0%	0.80
Cervical	8919	23.3%	9640	21.1%	0.23	23.4%	21.1%	0.14
Colorectal	8135	8.7%	7740	9.3%	0.29	9.0%	9.3%	0.53

Table 3b. Practices in top tertile of TopCare delegate use

	Inter- vention Number	Inter- vention Rate	Control Number	Control Rate	P-value	Inter- vention Rate	Control Rate	P-value
All eligible cancers	6276	22.3%	7678	16.9%	0.003	20.8%	16.9%	<0.001
Breast	2503	26.5%	2811	23.1%	0.06	26.4%	23.1%	0.06
Cervical	3166	28.4%	3599	18.7%	0.002	28.2%	18.7%	<0.001
Colorectal	2279	9.3%	3262	9.4%	0.92	9.7%	9.4%	0.79

* Adjusted rates and p-values obtained from mixed effects models comparing intervention and control groups controlling for patient age, ethnicity, insurance status, primary language, time since last practice visit, patient-physician linkage, and gender (for colorectal cancer and all screenings combined) while accounting for clustering by primary care physician or practice in a mixed effects model.

The overall adjusted rate of a patient completing all eligible cancer screening tests in intervention and control patients was similar (rate difference: 0.25%; 95% CI: -2.18% – 2.67%). There was no patient, physician or practice subgroups in which the intervention was more effective (Figure 3). Among subgroup comparisons for individual cancers, only the adjusted rate of breast cancer completion was higher among intervention patients compared to control patients seen in a health center (rate difference: 10.39%; 95% CI: 5.27% - 14.28%, data not shown).

Unadjusted screening rates among all eligible patients (regardless of intervention or control status) over time are shown in Table 4. Each cross-sectional time period is from June 15th to June 14th of the following year. Modest increases in screening rates were seen among all cancers combined (77.0% in 2009-2010 to 77.6% in 2011-2012 after the intervention), breast cancer (78.5% in 2009-2010 to 79.5% in 2011-2012), and colorectal cancer screening (71.7% in 2009-2010 to 73.8% in 2011-2012). Screening rates for cervical cancer screening decreased slightly over time. The increase in screening over time for all cancers combined and colorectal cancer screening were limited to physician-connected patients.

Table 4. Cancer screening rates among eligible patients over 1-year periods – Unadjusted Cancer Screening Test Completion Rates

	All Patients	Physician-Connected Patients	Practice-Connected Patients
All Cancers			
2011 – 2012	77.6%	80.0%	71.0%
2010 – 2011	77.2%	79.6%	71.2%
2009 - 2010	77.0%	79.2%	72.0%
Breast Cancer			
2011 – 2012	79.5%	82.2%	66.9%
2010 – 2011	78.7%	81.6%	65.9%
2009 - 2010	78.5%	81.5%	66.3%
Cervical Cancer			
2011 – 2012	79.8%	82.2%	75.2%
2010 – 2011	79.7%	82.3%	75.0%
2009 - 2010	80.2%	82.7%	76.1%
Colorectal Cancer			
2011 – 2012	73.8%	76.5%	58.8%
2010 – 2011	73.1%	75.6%	59.3%
2009 - 2010	71.7%	74.3%	59.0%

Results of the cost-effectiveness analyses will be detailed in the final report for the companion R03 grant award (R03-HS020308).

Discussion

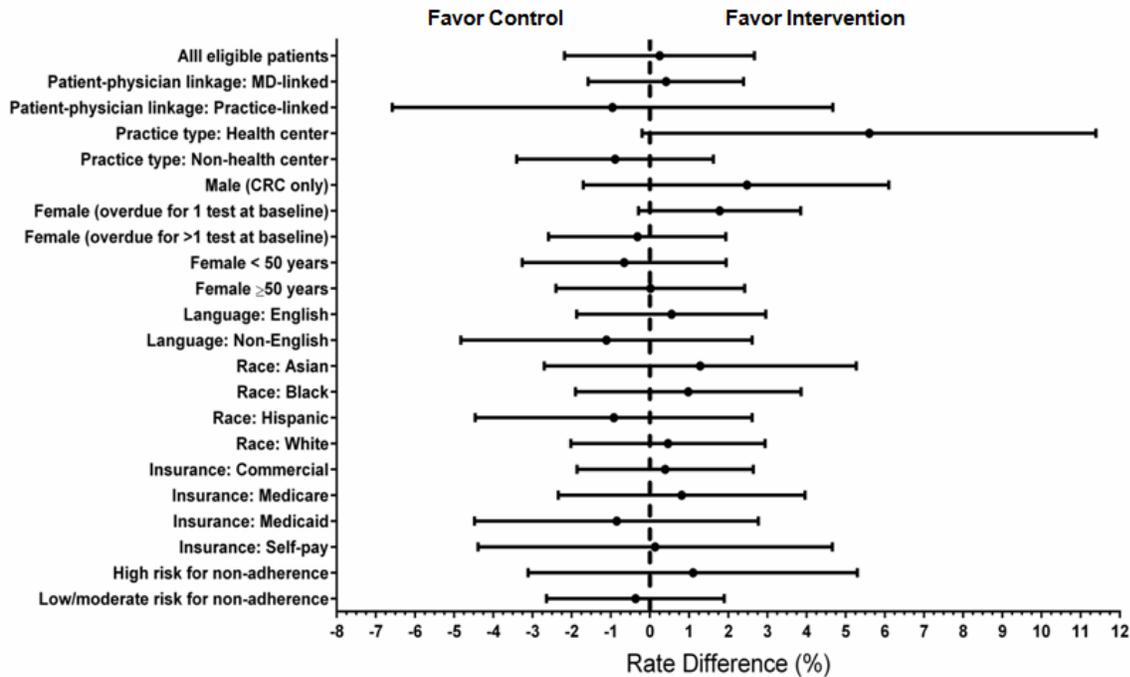
This study was designed to compare cancer screening rates among patients eligible for breast, cervical and/or colorectal cancer as part of a visit-independent, population management IT system within a primary care network. Over a 1-year study period, involving PCPs in the screening process did not increase testing rates compared to an automated reminder system that did not involve PCPs. However, similar screening rates were achieved with significantly fewer patient contacts in intervention practices where PCPs screened their overdue list.

Prior studies have shown that non-visit based reminder systems can increase rates of preventive cancer screening (Steele RJ et al, *BMJ* 2010; Chaudhry R et al, *Arch Intern Med* 2007; Everett T et al, *Cochrane Database Syst Rev* 2011; Green BB et al, *Ann Intern Med* 2013; Sabatino SA et al, *Am J Prev Med* 2012; Sequist TD et al, *Arch Intern Med* 2009; Yabroff KR et al *Cancer Epidemiol Biomarkers Prev* 2011; Muller D et al, *AMIA Annu Symp Proc* 2009; Wagner TH, *Am J Prev Med* 1998). The current study demonstrates that an automated reminder system without physician input led to similar screening rates for patients who appeared overdue for up to three widely recommended cancers; breast, cervical and colorectal (Moyer VA et al, *Ann Intern Med* 2012; Nelson HD et al, *Ann Intern Med* 2009; Qaseem A et al, *Ann Intern Med* 2012). We previously demonstrated that a similar population management system involving PCPs resulted in higher rates of breast cancer screening over a three year follow-up period compared to usual care that involved visit-based reminders in an electronic health record (Atlas SJ, *Am J Manag Care* 2012). The one year results reported here for the intervention and control groups are similar to those seen in the intervention group of our prior breast cancer screening study, all of which are better than the rates seen in the usual care control group (Atlas SJ, *J Gen Intern Med* 2011). However, comparing screening rates in the two years prior to the study period, there were minimal increases in overall completion rates during the study period. Further analyses are ongoing to examine changes in screening over time.

Though physician involvement did not increase screening rates, fewer patient contacts were needed in intervention practices where PCPs screened their overdue list, implying that PCPs could accurately exclude patients who did not need or would not undergo screening. Moreover, in practices where PCPs were more likely to screen overdue lists and practice delegates were more likely to document patient contacts, higher rates of screening were seen, especially for breast and cervical cancer. Future studies will examine the cost-effectiveness of involving PCPs in preventive cancer screening using population management systems.

Our study did not evaluate whether non-visit based population management systems could be used to remove tasks from busy clinical encounters currently embedded in EHR reminders. It is likely that as practices move to the patient centered medical home model of team-based care, more of these routine activities will be performed by non-clinical staff thereby freeing up the time of clinical staff for other activities that may be harder to perform by others or outside of the office visit (Baker AN et al, *Qual Saf Health Care* 2009; Bates DW et al, *Health Aff* 2010). Thus, non-visit based population management will likely continue to function as fail-safe systems when visit-based systems fail due to competing demands for time during the visit or when regular follow-up visits do not occur.

Figure 3. Adjusted rate differences and 95% confidence intervals for all cancer screenings combined in intervention and control groups in patient and practice subgroups. Rate differences compare patients in intervention and control groups controlling for age, ethnicity, insurance status, primary language, time since last practice visit, patient-physician linkage, and gender while accounting for clustering by primary care physician or practice in a mixed effects model. For each subgroup analysis, the analogous variable was removed from the model if necessary.



Limitations

Several important limitations are worth noting. First, our network had high baseline rates of preventive cancer screening, so it is possible that the small improvements in screening noted here may be larger in systems that start with lower rates of test completion. Second, though providers in intervention sites used the tool to screen overdue patients, practice delegates in both intervention and control practices conducted limited patient outreach. This lack of practice delegate outreach may have undermined the hypothesis that involving PCPs would improve the effectiveness of care. Specifically, if PCPs identified individuals for targeted outreach as well as individuals not needing screening (deferrals), then those provider’s delegates would have “more accurate” lists and their time commitment would be more likely to identify patients truly needing screening. Redesigning workflow to better involve practice delegates may increase the impact of PCP involvement (Zai AH et al, *J Am Med Inform Assoc* 2008; Zai AH et al, *J Am Med Inform Assoc* 2013). Third, our intervention was independent of electronic health record visit-based reminders. The high screening rates suggest that non-visit based population management systems could be used to remove tasks from busy clinical encounters (Ayanian JZ et al, *J Gen Intern Med* 2008).

Finally, use of patient navigators by intervention PCPs was limited because the program was not in place at the start of the study. Future studies should examine how population management

systems can efficiently use patient navigators for those patients needing more assistance to complete cancer screening (Zai AH, J Am Med Inform Assoc 2013).

Conclusions/Significance

To deliver better care at lower cost, current health care delivery models will need to undergo a fundamental restructuring (Lukas CV et al, Health Care Manage Rev 2007; Sepulveda MJ et al, Health Aff 2012; Wang MC, Jt Comm J Qual Patient Saf 2006). Health information technology, such as our population management system, offers the possibility of such transformational change.

We have demonstrated that an automated, non-visit based system for comprehensive preventive cancer screening that identifies eligible individuals overdue for tests, contacts them, and then tracks them for test scheduling and completion, results in similar screening rates compared to a system that involves PCPs in identifying patients for outreach. However, such automated systems result in significantly more patient outreach that may become burdensome to patients as these systems grow in scope and include a broad range of prevention and disease management registries and interventions. Future research should seek to identify where provider input is critical even when processes are highly automated.

Implications

1. Advanced health information technology can perform population-based comprehensive screening for preventive cancer within large, integrated primary care networks.
2. An automated, non-visit based reminder system for comprehensive preventive cancer screening resulted in similar screening rates but more patient contacts compared to a system that involved PCPs in identifying patients for outreach.
3. At present, such population management systems may offer the greatest opportunity to improve the effectiveness and efficiency of care in primary care networks with lower rates of test completion.
4. As reimbursement changes from fee-for-service to capitated global payments, population management systems offer the possibility to transform care by identifying opportunities for managing patients outside of one-on-one office visits.
5. Future research should seek to identify preventive care and disease management scenarios that may be good candidates for highly automated, non-visit based models of care delivery.

List of Publications and Products

1. Zai AH, Kim S, Kamis A, Hung K, Ronquillo JG, Chueh HC, Atlas SJ. Applying operations research to optimize a novel population management system for cancer screening. *Journal of the American Medical*

Informatics Association. 2013 Sep 16, Epub ahead of print.

2. Atlas SJ, Zai AH, Ashburner JM, Chang Y, Percac-

Lima S, Levy DE, Chueh HC, Grant RW. Role of the Primary Care Provider in Cancer Screening using a Novel Population Management System. *JAMA Intern Med*. Under Review.