Grant Final Report

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Economic Analysis of an IT-Assisted Population-Based Cancer Screening Program

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Abstract

Purpose: Evaluate the incremental cost per patient screened of two population-centered, health information technology (HIT)-based tools compared in a clinical trial.

Scope: Screening and cost outcomes were measured from the perspective of 18 practices in an integrated care organization.

Methods: The HIT system included a patient registry which continuously tracked patients' screening status for breast, cervical, or colorectal cancer. The control program used an automated outreach algorithm to encourage overdue patients to be screened. The intervention program leveraged providers' personal knowledge to update patients' screening status or designate them for specific outreach strategies (personalized letter, phone, or navigator outreach). Nine practices each were randomized to treatment or control. Effectiveness was measured as the proportion of time eligible patients were up to date on all pertinent screening. We used micro-costing techniques to estimate the costs of software development and practice implementation over 1 year. Monte Carlo methods were used to aggregate costs accounting for uncertainty in parameter values.

Results: Over the study period, eligible patients in intervention and control groups (n=103,870 total) spent equal time with all pertinent screenings completed (79.9% vs. 79.6%, p=0.87). Costs were lower for control than intervention ($167,170 vs. $215,377; 95% CI for difference $1,717-$126,321). Thus, an automated program of patient outreach achieved identical screening success at lower cost compared to one designed to leverage providers' personal knowledge of their patients. Standardized software design could reduce one-time costs and make the intervention more cost-effective compared to control.

Key Words: information technology; registries; screening; visit-independent care; cost-effectiveness analysis

Final Report

Purpose

The Aim of the project was to evaluate the efficiency of a novel health information technology (HIT) tool designed to improve population-based management of breast, cervical, and colorectal cancer screening either through an automated, escalating outreach program alone (augmented standard care, ASC) or an extension of that program (TopCare) which leveraged physician knowledge and engagement to improve the efficiency of the automated outreach. A randomized trial designed to develop and evaluate TopCare was conducted in parallel under a separate grant (R18-HS018161). The primary outcome of the trial was improvements in guideline-indicated screening rates in our primary care patient population. In this R03, our goal was to evaluate the incremental cost per patient screened of the TopCare and ASC programs compared to baseline standard care (BSC, usual visit-based care) from an integrated care organization (ICO) perspective; and evaluate the impact of alternative payment mechanisms (such as pay-for-performance) on cost-effectiveness from an ICO's perspective.

Scope

Despite the high cost of U.S. health care and the increasing adoption of basic HIT, studies reveal low rates of appropriate preventive screening. Only half of eligible patients are up-to-date on all indicated preventive cancer screening tests in a given year. Despite widely disseminated guidelines to providers and patients supporting preventive screening for breast, cervical and colorectal cancer, in 2008 screening was up to date for only 67%, 78%, and 53% of the eligible population for these three cancers, respectively. Preventive care is a fundamental primary care physician (PCP) responsibility. The current expectation is that preventive care will be delivered in the context of routine visits; most informatics-based interventions have relied predominantly on computer-assisted decision support and physician reminders offered at the point of care. At the same time, the many demands on PCP time continue to increase. However, new capitated payment models with risk-adjusted incentives tied to the attainment of preventive care targets (pay-for-performance, P4P, incentives), on the other hand, have the potential to greatly improve PCPs' success in providing essential preventive care that is not linked to face-to-face visits. These incentives will help drive new demand for non-visit-based strategies for improving preventive care, such as cancer screening. Our R18-funded clinical trial was designed to analyze the effectiveness of a novel registry-based automated outreach program (ASC) compared to one that sought to streamline outreach by leverage physicians' knowledge of their individual patients (TopCare). It was hypothesized that although TopCare required greater human effort, it would be more efficient at targeting particular outreach strategies to specific patients; under TopCare, patients would receive fewer total contacts and would spend less time overdue for screenings. For this R03, we endeavored to weigh the costs associated with ASC compared to TopCare in light of difference in their effectiveness at promoting screening. The results of this cost

effectiveness study will provide key information to justify the value of this approach relative to other strategies for improving screening rates.

Our screening outreach focused on breast, cervical, and colorectal cancer, three cancers for which there is a strong evidence base and guidance regarding screening methods, at-risk patient populations, and the timing and frequency of screening. Our efforts took place in the context of a primary care practice based research network set within a large integrated care organization (the Massachusetts General Primary Care network). Twenty practices from this ICO were included in the study. Two were used as pilot sites to test the intervention, and 18 were randomized as part of the clinical trial. The trial took place over 1 year. In that time, there were 103,870 patients the HIT tool identified as eligible for screening for at least one of the three cancers.

Methods

From June 15, 2011 to June 14, 2012, the team conducted a clinical trial comparing two alternative, novel primary care HIT systems designed to harness patient registry data to improve preventive screening rates for breast, cervical, and colorectal cancer. The trial was conducted under R18-HS018161. The cost-effectiveness analysis (CEA) covered in this project (R03-HS020308) was conducted in parallel with the clinical trial. Whereas the clinical trial was designed to compare two novel HIT systems to each other, the CEA also compares these two strategies to usual care as it existed before the introduction of the HIT system. The goal was to understand the relationship between a primary care health system's resource outlays and any improvements in clinical care that may have resulted.

Prior to the introduction of the registry-based HIT system, screening reminders came in two forms. Most commonly, a physician accessing a patient's electronic health record (EHR), usually as part of a clinical visit, would see an alert if that patient was overdue for screening. Alternatively, patients who had previously received mammograms from network radiology providers would receive mailed reminders from the radiologists' offices when they were due for their next screening. Patients overdue for cervical cancer screening would be tested at the time of a routine preventive visit with the provider who performed routine gynecologic care. There was no formal process for gastroenterologists to contact patients due for routine colorectal cancer screening who had previously undergone testing and were now overdue. Together these practices constitute BSC.

The novel HIT system tested as part of the clinical trial included a patient registry which continuously identified patients in the network who were overdue for breast, cervical, or colorectal cancer screening; permitted targeted outreach; and tracked tests scheduled and completed. The ASC arm used an automated outreach process where overdue patients were first sent letters asking them to directly schedule an overdue test. They could also contact a call center if they had already received screening (e.g. outside the care network or more recently than could be ascertained through the HIT system) or if they did not wish to be screened or were not due for screening for other reasons (e.g. no longer in need of Pap tests due to hysterectomy). If an overdue test was not scheduled or completed, the patient transferred to a list monitored by a delegate in the provider's office who would call the patient. If there was still no response, patients at high risk for non-adherence were transferred to navigators who would work closely with patients to complete screening. The intervention program ("TopCare") leveraged providers'

personal knowledge to update patients' screening eligibility and status or designate them for personalized letter, phone, or navigator outreach. If a provider did not act within 8 weeks, the patient defaulted to the automated outreach used in the control arm.

For the trial, nine practice sites were randomized to each study arm. 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 used micro-costing techniques to estimate the costs of the HIT tool, HIT training, mailing materials, and clinical staff time over 1 year. We estimated software costs from the real-world perspective of a provider organization putting in place a bespoke system. The cost of the software was estimated by an expert consulting firm (Massachusetts Technology Consultants) that examined the software and interviewed the IT staff who developed it to understand the software's structure, how it was developed, and the time it took to construct critical components of the software infrastructure. These included coding the algorithm that translates clinical data into guideline-based screening recommendations, coding to execute data transfer between various clinical HIT systems as necessary to build the registry, project management, and for the TopCare intervention arm, the development of a refined user interface that clinicians in the network were comfortable engaging. In assessing the cost of the HIT tool, we did not include the hardware and software costs of the existing systems on which the tool was built.

To train the clinical staff how to use the HIT tool, a series of group training sessions were conducted. Physicians and office staff were trained separately. Physicians were trained by a fellow physician and the project manager. Other staff were trained by the project manager. Attendance at each training session was recorded. Refresher training and helpline support were also available and tracked. The estimated cost of training over the course of the study year was based on the time spent in training and the effective hourly wage (including fringe benefits) of both the trainers and the trainees. While lower wage staff could have been used to conduct the trainings, it was our assessment that higher level trainers would be more effective at achieving buy-in from physician and non-physician clinical staff.

The cost of mailing materials was ascertained directly from administrative records. We tracked those letters sent as part of TopCare and ASC, but not those sent as part of the regular radiology department practice. The volume of mail sent from radiology was unchanged by the materials sent as part of the clinical trial, and therefore is not included explicitly in our cost calculations.

To track how the HIT tool affected time use, surveys were administered to physicians and delegates asking the following question: "Thinking of the effort generated by a recent, typical half-day clinical session, about how much time did you spend on the following types of cancer screening, including time spent before, during, or after the session?" Respondents answered separately for breast, cervical, and colorectal cancer screening. The surveys were administered prior to the launch of the HIT tool (during BSC), and again approximately 1 year later. The responses were compared, and the change in time spent on screening was calculated for each study arm. Costs were estimated by aggregating the number of physician or delegate FTEs, the number of work days per year, the average salary (wage + fringe) for physicians or delegates,

and the change in time devoted to screening as a function of the study arm to which they were assigned.

Patient navigators, as part of their usual responsibilities, kept detailed records of the time spent reaching out to each patient. The call center and medical records staff tracked the number of calls received or records updated, but not the exact time each took. Each estimated the typical amount of time an action took, as well as the range from shortest to longest from which a distribution could be estimated. All time-use data were combined with relevant wage and fringe benefit information to estimate the costs of these activities.

Monte Carlo methods were used to aggregate costs taking into account any uncertainty in individual parameter values. For training and mailing costs, there was no uncertainty. For the HIT software and clinical staff time, costs were assumed to follow normal or log-normal distributions. We conducted 100,000 simulations using "common random number" methodology, to increase simulation efficiency. The mean, median, and 95% confidence bounds were calculated for each cost component and for overall costs by study arm. Mean, median, and 95% confidence bounds were also estimated for relevant differences between cost estimates.

Results

Principal Findings

Over the study period, there were 103,870 patients who met the eligibility criteria for screening for at least one cancer. Results of the R18 trial indicate that there was not a significant difference in the percent of time over the study period spent up-to-date on all screening between the TopCare and ASC arms (81.6% vs. 81.4%, p=0.84). In Table 1 and Figure 1 below, we present preliminary results of the CEA. At present, we are only able to compare TopCare with ASC because the effectiveness estimates (cancer screening rates) are not yet available for BSC pending work by the R18 team works to standardize patient denominator populations, thus ensuring meaningful comparisons.

Table 1 shows our estimates for each cost component by study arm. The software is broken down into user interface (UI) and back-end costs; only the UI costs vary between the two arms. The mailing costs vary according to the number of screenings for which a patient was overdue. Each letter had a cover page plus one page per overdue screening test. Training was broken down by the type of office staff *receiving* the training, as well as the trainers' time. The use costs are the cost of staff/clinician time to facilitate cancer screening. Call center costs are the costs of fielding appointment requests, screening status updates, and EHR updates.

Table 1. Component costs by study arm

	ASC	TopCare
Software: Non-UI costs	79,040	79,040
Software: UI costs	41,600	83,200
Mailing: 2 page letter	12,893	8,930
Mailing: 3 page letter	1,665	1,422
Mailing: 4 page letter	328	261
Training: Delegates	720	2,154
Training: Case managers	0	566
Training: Navigators	109	109
Training: Physicians	3,186	9,946
Use: Delegates	3,243	8,538
Use: Navigators/Interpreters	5,952	5,952
Use: Physicians	15,835	12,996
Call Center: Call response	1,371	973
Call Center: EHR entries	740	525
Total	166,682*	214,612*

*Totals differ slightly from overall costs due to cumulative rounding errors.

Figure 1 shows a comparison of the compiled costs for the TopCare and ASC arms. We estimated that TopCare cost $215,377 and ASC cost $167,170 over the course of one year (difference $48,207; 95%CI $1,717 to $126,321). The largest driver of cost was the software itself.

In separate analyses (Figure 2), we assessed one-time versus ongoing costs. One-time costs were the costs of the software and costs for training. Ongoing costs were mailings, call center and medical records costs, and clinical staff costs. One-time costs were lower for ASC than for TopCare due to the cost of developing the UI on the software ($125,144 vs. $175,780, respectively). Ongoing costs were higher for ASC than TopCare ($42,026 vs. $39,596, respectively), but it would take more than 20 years for the difference in ongoing costs cover the difference in one-time costs.

Figure 1. Compiled costs for TopCare and ASC

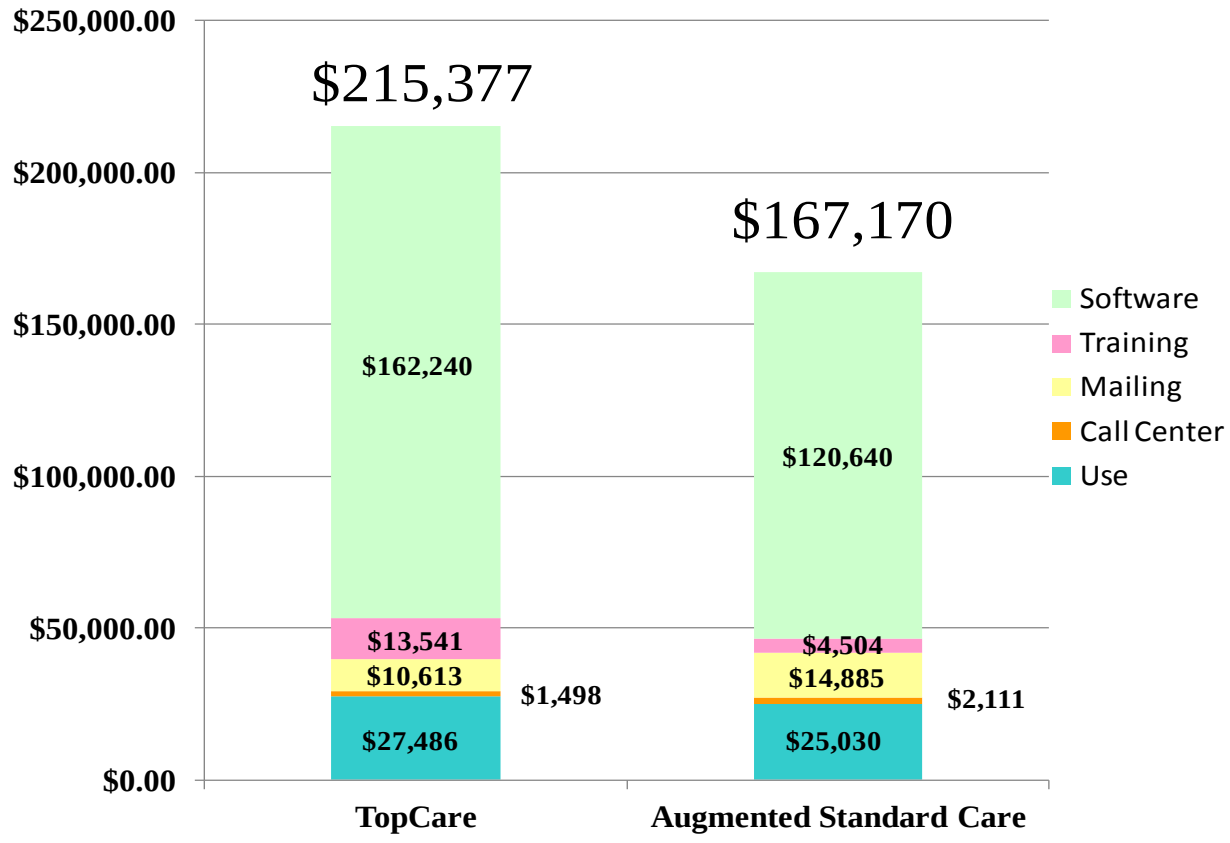
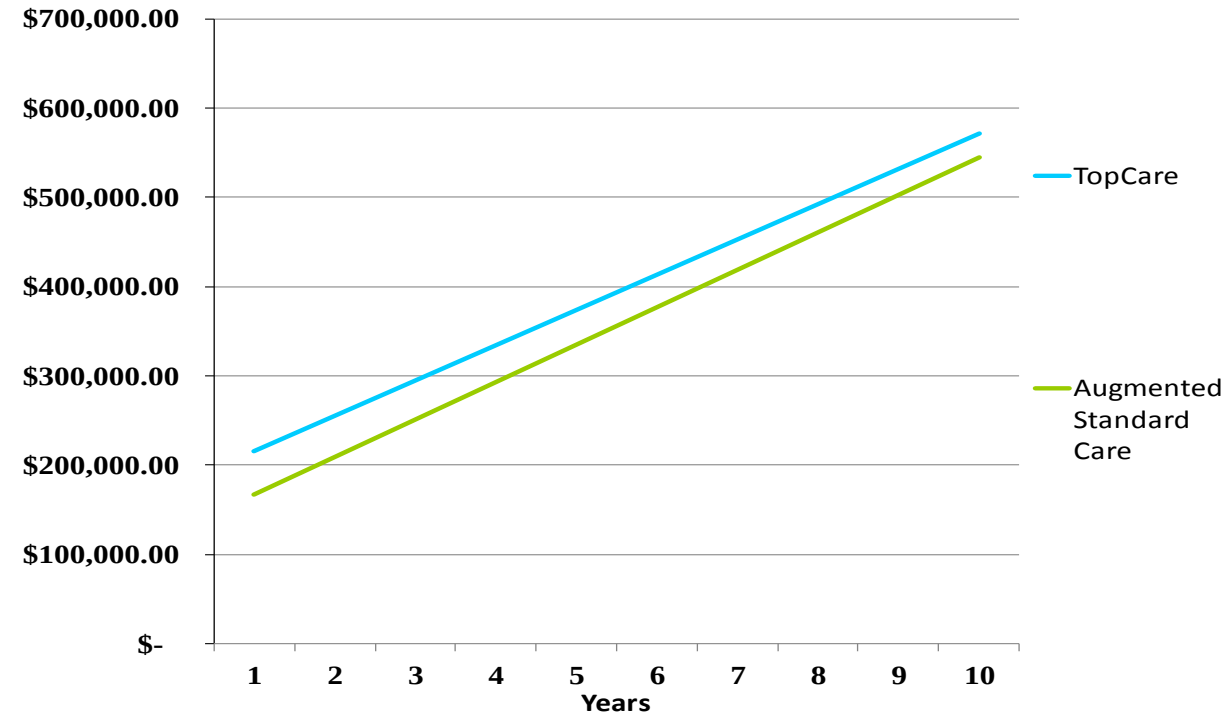


Figure 2. Projected cumulative costs over 10 years



Analysis of Aim 1a (impact of alternative financing mechanisms) awaits the finalized estimates of BSC, ASC, and TopCare screening rates from the R18 investigators.

Discussion, Significance, Implications

Results from the clinical trial indicate that in the setting of this ICO, there was no gain in effectiveness from leveraging physicians' knowledge of their patient panels into determining optimal outreach to promote population-based cancer screening. As such, ASC "dominates" TopCare from a cost-effectiveness perspective: it is less costly and no less effective. The failure of TopCare to improve on ASC may stem from the high baseline rate of cancer screening in our practices. Another factor was suboptimal physician and practice engagement with the TopCare tool. Though 85.9% (79 of 92) of physicians in the TopCare practices used the tool, they reviewed and took action on only 48.2% of patients listed as overdue for screening. Sub-analyses suggest screening rates were somewhat higher for patients in practices where physicians and delegates were more likely to actually use the TopCare tool. Future refinements of the TopCare tool may focus on determining whether efforts to increase engagement with the tool, through different training methods or using incentives, would result in improved screening rates relative to ASC. Such strategies would bear a cost which would have to be considered against the magnitude of improvements in screening.

The overall costs of TopCare and ASC alike are driven by the underlying software. There are reasons these costs may be different in other settings. These tools were developed *de novo*, specifically in the context costs of one ICO. Certain elements of the design process represent one-time costs, not just for this ICO, but for any other ICO that might adopt the software. For example, once a UI has been constructed, it does not need to be recreated in each ICO where the software is deployed. Other elements of the software design will be similarly portable to other settings. That would tend to lower the cost of the software overall, and reduce the differences in costs between systems using the TopCare versus ASC approaches. The software component whose cost will vary greatly from setting to setting is the coding to integrate clinical systems and create suitable patient registries. In ICOs with modern clinical IT infrastructures that were developed and deployed in a coherent fashion, creating the necessary registry will prove relatively straight-forward. However, creating registries capable of accurate, real-time updates in ICOs operating numerous and disparate legacy systems will pose major challenges, and will greatly increase the cost of the software. The costs of setting up a system's registry capability are common to both the TopCare and ASC approaches and so will not affect their appeal relative to one another; rather the costs will diminish the appeal of adding such capability independent of a major HIT overhaul.

Two findings with respect to the TopCare arm, specifically, may have bearing on the future cost-effectiveness of physician-mediated population-based preventive care. First, on the whole, physicians in the TopCare arm spent less time addressing cancer screening with no reduction in screening rates. Given the warnings about PCP shortages, this will help the system get the most out of the PCP workforce. Second, fewer letters were sent to patients in the TopCare arm. As population-based care management becomes increasingly prevalent, there is a risk that patients will become desensitized to notices from their physicians and may be more likely to ignore such outreach. In that circumstance, limiting the amount of outreach directed towards patients may improve the effectiveness of those efforts.

Conclusions

An automated program of patient outreach achieved identical screening success at lower cost compared to one designed to take advantage of providers' personal knowledge of their patients. Standardized software design could reduce one-time costs and make the intervention approach more cost-effective compared to the control.

List of Publications and Products

Levy DE, Munshi V, Ashburner JM, Zai AH, Grant RW, Atlas SJ. The effectiveness and costs of two population-based cancer screening programs: The value of PCP input. Poster presented at the 2013 annual meeting of the Society for General Internal Medicine in Denver, CO. Also presented at the 2013 Academy Health annual research meeting in Baltimore, MD where it was featured in a "poster walk," a guided-tour of the exhibit hall featuring work of particular interest and merit.