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Colorectal Cancer Screening Interventions in 2 Health Care Systems Serving Disadvantaged Populations: Screening Uptake and Cost-Effectiveness

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Abstract

BACKGROUND: The objectives of the current study were to assess changes in colorectal cancer (CRC) screening uptake and the cost-effectiveness of implementing multiple evidence-based interventions (EBIs). EBIs were implemented at 2 federally qualified health centers that participated in the Colorado Department of Public Health and Environment's Clinic Quality Improvement for Population Health initiative.

METHODS: Interventions included patient and provider reminder systems (health system 1), provider assessment and feedback (health systems 1 and 2), and numerous support activities (health systems 1 and 2). The authors evaluated health system 1 from July 2013 to June 2015 and health system 2 from July 2014 to June 2017. Evaluation measures included annual CRC screening uptake, EBIs implemented, funds received and expended by each health system to implement EBIs, and intervention costs to the Colorado Department of Public Health and Environment and health systems.

RESULTS: CRC screening uptake increased by 18 percentage points in health system 1 and 10 percentage points in health system 2. The improvements in CRC screening uptake, not including

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AUTHOR CONTRIBUTIONS

Christen L. Lara: Data collection and analysis, writing–original draft, and writing–review and editing. **Kelly L. Means**: Writing–original draft and writing–review and editing. **Krystal D. Morwood**: Writing–original draft and writing–review and editing. **Westley R. Lighthall**: Writing–original draft and writing–review and editing. **Sonja Hoover**: Data collection and analysis, writing–original draft, and writing–review and editing. **Florence K.L. Tangka**: Conceptualization, writing–original draft, and writing-review and editing. **Cynthia French**: Project administration and writing–review and editing. **Krystal D. Gayle**: Project administration and writing–review and editing. **Amy DeGroff** Project administration and writing–review and editing. **Sujha Subramanian**: Conceptualization, data collection and analysis, writing–original draft, and writing–review and editing.

CONFLICT OF INTEREST DISCLOSURES

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the cost of the screening tests, were obtained at an added cost ranging from $24 to $29 per person screened.

CONCLUSIONS: In both health systems, the multicomponent interventions implemented likely resulted in improvements in CRC screening. The results suggest that significant increases in CRC screening uptake can be achieved in federally qualified health centers when appropriate technical support and health system commitment are present. The cost estimates of the multicomponent interventions suggest that these interventions and support activities can be implemented in a cost-effective manner.

Keywords

cancer screening; Colorado; colorectal cancer; cost-effective; evaluation

INTRODUCTION

The burden from colorectal cancer (CRC) could be reduced if substantially more individuals aged 50 years to 75 years were screened for CRC as recommended.[1] In Colorado, CRC is the second leading cause of death from cancer and the third most common cancer for both men and women. In addition, 1 in 21 men and 1 in 25 women in Colorado are expected to develop CRC during their lifetime, with approximately 1800 new CRC cases and >600 CRC deaths expected each year.[2] As a Medicaid expansion state, low-income Coloradans became eligible to enroll in Colorado's Medicaid program in 2014; as a result, the rate of uninsured Coloradans has decreased substantially from 14.3% in 2013 to 6.5% in 2017.[3] Despite increases in the insured population, relative increases in CRC screening rates have not been realized: the CRC screening rate among men and women aged 50 years to 75 years in Colorado was 65.5% in 2012 and 67.7% in 2016; approximately 500,000 Coloradans still are in need of CRC screening.[4,5]

Several patient-oriented and provider-oriented evidence-based interventions (EBIs) are recommended in *The Community Guide* to improve CRC screening uptake.[6] These include patient reminders, provider reminders, and provider assessment and feedback, as well as small media and the reduction of structural barriers. Interventions can be implemented as a single EBI or as multicomponent interventions that combine ≥2 intervention approaches recommended in *The Community Guide*, or ≥2 interventions to reduce structural barriers.[7]

The Colorado Department of Public Health and Environment (CDPHE) developed the Clinic Quality Improvement for Population Health (CQI) initiative to support and monitor the implementation of EBIs to improve CRC screening uptake within health systems. The CQI initiative was designed to assess screening uptake and capacity and provide EBI implementation support in coordination with breast cancer and cervical cancer screening, hypertension control, and diabetes control. In 2013, the assessment process was initiated with 3 health systems based on existing partnerships with the CDPHE and their status as federally qualified health centers (FQHCs) providing primary care services to largely low-income and uninsured populations. The CDPHE and health systems staff worked together to identify EBIs that alleviated patient barriers to service, incorporated EBIs into existing health system infrastructure, and leveraged funding from various sources. Two of the 3

health systems implemented EBIs to increase CRC screening uptake and the results of EBI implementation were included in the current study. The CDPHE received funds from the Centers for Disease Control and Prevention's Colorectal Cancer Control Program to administer the CQI initiative, and health systems received additional funding from the American Cancer Society for implementation.

The objectives of the current study were to assess changes in CRC screening uptake, to determine the percentage of patients within the clinic who are up to date with CRC screening after implementation of selected EBIs, and to analyze the cost-effectiveness of EBI implementation at the 2 health systems that participated in the first round of the CQI initiative. Although to our knowledge there have been many studies to date regarding the benefits of implementing EBIs,[6,8] the CQI initiative is unique in that multiple interventions were integrated within the existing processes and infrastructure. In addition, there is a limited economics evidence base, especially in support of multi-component interventions.[8] The effectiveness and cost evaluation of the CQI initiative will offer lessons concerning implementing and sustaining CRC screening interventions within FQHCs. Findings from the current study also could have direct relevance for increasing screening uptake among low-income or uninsured individuals served at FQHCs, who have historically low rates of CRC screening uptake. Data from the 2016 Uniform Data System indicate that CRC screening uptake at FQHCs is nearing 40%, and therefore targeted interventions will be required to increase this rate to meet national targets.[10]

MATERIALS AND METHODS

Health Systems Overview and EBIs Implemented

We included 2 health systems in the current study that provided primary care services to underserved adult populations and that were in geographic regions of Colorado with lower CRC screening uptake compared with the state average. Health system 1 had 9 clinic locations and health system 2 had 4 clinic locations. In 2013, CDPHE public health staff and medical record reviewers measured organizational capacity, ongoing screening and quality improvement activities, patient barriers to screening, and screening uptake. This assessment was completed for CRC along with all other disease areas included in the CQI initiative. We reviewed results with health systems staff and identified areas for improvement. Both health systems were interested in making changes to their clinic processes or infrastructure; because the CQI initiative offered the simultaneous delivery of interventions for several chronic diseases, interventions selected by both health systems affected other disease areas. The CDPHE executed contracts with health systems 1 and 2 to provide funds for EBI implementation and provided technical assistance.

The EBIs implemented and the implementation period varied for health systems 1 and 2. For health system 1, the CDPHE supported the establishment of provider assessment and feedback processes beginning in July 2013 by facilitating clinic-specific review of CRC rates with quality improvement and data management staff. Variations across clinics, barriers, and opportunities to improve screening uptake were discussed and a plan was established to implement patient and provider reminder systems. Between July 2014 and June 2015 (year 2), a provider reminder system for CRC screening was established by

standardizing CRC screening policies and implementing a centralized data reporting and analytics solution to prompt the clinic when clients were due for screening services. The provider reminder system was implemented through previsit planning, in which front desk staff would determine whether patients with appointments scheduled for the following day were due for CRC screening and flag those due for the medical provider. In addition, patient reminders were mailed to those due for screening, and fecal immunochemical test (FIT) kits were included in these mailings to eligible patients at 3 clinics. FIT kits were distributed at all clinics during nonacute visits to eligible patients as well. Standardized protocols were established across all clinics in the health system to follow up with patients who did not return FIT kits. Throughout the implementation period, the health system's quality improvement staff monitored CRC rates monthly and provided this information back to clinic staff.

A similar engagement process was followed with health system 2. CDPHE staff reviewed all compiled information with health systems staff. Between July 2014 and June 2015, the CDPHE supported the establishment of provider assessment and feedback processes that were begun in July 2013 by facilitating clinic-specific review of CRC rates with quality improvement and data management staff. Between July 2015 and June 2017, health system 2 standardized clinic policies and workflows to make national CRC guidelines available at the point of care, offered FIT kits to eligible patients during nonacute visits, provided decisional support tools to educate patients regarding CRC screening options, and educated providers on national CRC screening guidelines. In addition, to support a patient reminder system, a CRC patient registry was created and a standardized process for identifying and contacting patients who were not up to date with CRC screening was established.

Data Quality Assessment to Ensure Accuracy of CRC Screening Uptake Measurements

The CDPHE assessed the accuracy of CRC screening data reported through each health system's electronic health record (EHR) by comparing the volume and percentage of patients meeting CRC screening guidelines assessed via manual medical record review. Manual medical record review for patients aged 50 to 74 years who had an office visit during the measurement period was based on a standardized weighted random sampling approach developed by the CDPHE. Sampling was completed for each clinic for which the volume of patients aged 50 to 74 years was >300 and was sufficient to assess CRC screening uptake among age-eligible populations at 90% confidence with a maximum margin of error of 10%, assuming 50% probability of a person meeting screening guidelines. Finite population correction factor was applied.[11] Patients were considered to be in compliance with CRC screening guidelines if they had undergone a colonoscopy within the last 10 years, a sigmoidoscopy within the last 5 years, or a fecal occult blood test/FIT within the last year. Patients with a total colectomy were excluded from analysis.

For health system 1, a total of 1081 records were reviewed across 9 clinics representing an active patient population of 10,320 persons; individual clinic size ranged from 454 to 2184 individuals. For health system 2, a total of 300 records were reviewed: 288 records were from the health system's 2 larger clinics with CRC screening-eligible patient populations of 3486 and 1896, respectively, and the remaining charts of CRC screening–eligible patient

populations were reviewed at the health system's 2 smaller clinics of fewer than 300 patients each. This allowed the CDPHE to assess health system—wide CRC screening uptake at 90% confidence with a maximum margin of error of 10% and clinic-specific CRC screening uptake at larger clinics.

Health systems electronically reported CRC uptake using electronic clinical quality measures standards for CRC screening, which align with national CRC screening guidelines for all patients, with an office visit occurring during the measurement period. EHR-reported uptake was considered accurate if it fell within 10 percentage points of the rate established through manual record review. CRC cancer screening uptake was reported annually via health system EHRs and was monitored for expected changes and consistency in the size of the eligible population. Based on this methodology, rates were validated at baseline and analyzed for 8 of 9 health system 1 clinics and all health system 2 clinics. Because a manual record review was not completed in subsequent years, information from this study for the one clinic that had an inaccurate EHR-reported rate at baseline was excluded.

Data Sources for Effectiveness and Cost Measures

The objective of the current study was to capture the incremental or additional expenditure required to implement the interventions from the health system perspective and assess costs associated with the establishment and ongoing support of EBIs. Data collected for this study included annual CRC screening uptake and EBIs in place, funds distributed to each health system to implement EBIs and the amounts expended, and the administrative costs to the CDPHE related to the health systems studied. The primary source of data was the standardized information stored in a CDPHE-administered relational database. This database contained data at multiple levels, including details related to the health system, clinics, and aggregated patient statistics. Detailed implementation plans provided information regarding the types of EBIs and support activities that were introduced into the health system clinics and the timing of the interventions. The number of individuals eligible for screening and the number screened during each annual period from July to June were abstracted from the database for each health system.

Data extracted from the CDPHE database were combined with archived data held by CDPHE programs on contracts, budget, and spending. The CDPHE used information regarding the budget, budget justification, and the spending reports for each annual period to estimate the cost related to the EBIs and support activities. Details that were available included staff time dedicated to specific activities (labor cost was estimated based on calculated hourly wages) as well as expenditures on nonlabor costs. Implementation costs for the health systems were estimated based on the funds received and expended. In addition to the health system costs, we also estimated the administrative cost for CDPHE staff to support activities related to CRC interventions and to provide technical support to the 2 health systems. We reviewed health system tracking logs and archived site reports to estimate the time spent by each CDPHE staff member. Hourly wages were used to determine the cost of the support activities. Funding was provided for multiple improvement activities and, when CRC-specific costs could not be ascertained, we allocated a percentage of the cost (based on the number of initiatives) to the EBIs and supporting activities. We included

details regarding salary and hours for staff involved in developing and implementing the interventions as well as the cost of travel, supplies, and contracts. We did not include the cost for health system staff who already were employed at the clinics and in administrative functions. In addition, we did not include the clinical cost of conducting the CRC screening tests and follow-up diagnostic services because our goal was to capture the cost of the interventions aimed at increasing screening uptake.

Data Analysis and Summary Statistics

For each health system, the number of individuals screened by any US Preventive Services Task Force guideline-recommended screening test, including fecal-based tests and colonoscopies, and the number of individuals eligible for screening were used to calculate the screening uptake for each annual period. We used the screening uptake for the annual period prior to implementation of the intervention as the baseline measure to evaluate the effectiveness of the intervention. During the baseline year, verified EHR-reported uptake measures were used. Individuals were considered up to date with screening if they had undergone a colonoscopy within the past 10 years, a flexible sigmoidoscopy within the last 5 years, or a fecal occult blood test/FIT within the last year. We presented the number of additional individuals screened for each annual period as well as across the entire intervention time frame. The cost estimates provided included the total additional cost of the intervention as well as the breakdown of the costs related to CDHPE and health system activities. Finally, to assess the cost-effectiveness of the multicomponent promotion intervention, we presented the incremental cost per person screened for each annual period as well as across all the intervention years.

RESULTS

Health System 1

Figure 1 presents additional individuals screened and the CRC screening uptake for annual periods across 8 clinics with verified CRC screening information. The numerator and denominator with which to calculate screening uptake are provided in Table 1. The baseline screening rate was 21.1%; this increased to 22.7% in year 1 as provider assessment and feedback processes were established and then to 39.2% in year 2 when provider and patient reminders also were implemented. An additional 491 individuals were screened for CRC in year 1 and an additional 2042 were screened in year 2.

As shown in Table 1, the cost for intervention activities (not including the clinical costs of screening) in year 1 was $3557, and was $56,667 in year 2. In year 1, the CDPHE incurred the majority of costs, whereas in year 2 the majority of costs were incurred directly by the health system. The incremental cost per person screened was $7.24 and $27.75, respectively, in year 1 and year 2. Overall, across the implementation period, 2533 additional individuals were screened at an added cost of $23.78 per person.

Health System 2

As reported in Figure 2, the percentage of individuals screened for health system 2 was 25.7% at baseline and 28.6%, 34.7%, and 35.4%, respectively, in years 1, 2, and 3. An

additional 101 individuals were screened for CRC in year 1, an additional 246 individuals in year 2, and an additional 596 individuals in year 3. Although the number screened increased the most in year 3, the number of individuals eligible for screening also increased in year 3 (Table 2), which affected the screening rate reported.

Table 2 presents the cost and incremental cost per person screened for each of the 3 annual periods of the intervention implementation. The total implementation costs were $821, $16,300, and $10,376, respectively, during years 1, 2, and 3; the cost for the entire 3-year period was $27,497. The incremental cost per person screened ranged from $8.21 to $66.26 for each annual period, with an overall added cost per person of $29.16 across the implementation periods.

DISCUSSION

The current study reports results from multicomponent interventions intended to increase CRC screening that were implemented in 2 health systems serving disadvantaged populations. Both health systems implemented EBIs from *The Community Guide*, including provider assessment and feedback, provider reminders, and patient reminders; they also strengthened CRC-related policies and procedures. The CRC screening uptake increased during the implementation period and likely contributed to improvements in CRC screening. We did not have a comparison group with which to systematically assess the impact of the interventions, but the contributions were substantially large enough to allow us to draw inferences. Health system 1 screened an additional 2533 individuals over 2 years, and health system 2 screened an additional 943 individuals over 3 years. CRC screening uptake increased by 18 percentage points in health system 1 and by 10 percentage points in health system 2 during the intervention implementation time frame compared with the annual period before implementation. These increases are similar to those reported in a recent review for *The Community Guide* that found that multicomponent interventions increased CRC screening uptake by a median of 15.4 percentage points (range, 6.0-21.6 percentage points).[9] It is important to note that the results obtained in the current study confirm that significant increases in CRC screening uptake can be achieved in the clinical practice setting of FQHCs when EBIs, along with appropriate technical support and health system commitment, are present. These results may support continued improvements in CRC screening uptake in FQHCs, which has increased nationally from 30.2% in 2012 to 39.9% in 2016.[9]

In both health systems, the improvements in CRC screening uptake were obtained at a reasonable cost, with the intervention costs ranging from $24 to $29 per person screened (not including clinical cost). In other CRC screening promotion intervention studies that have involved single interventions, the incremental cost per person successfully screened was reported to range from $13.14 to as high as $2602.[11–14] The cost estimates of the multicomponent interventions presented in the current study suggest that these interventions and support activities can be implemented at least as cost-effectively as single, stand-alone interventions. We note that the cost estimates varied by year because the efforts required to implement the interventions were not the same across all the years or across the health systems. For example, in health system 1, the cost in year 1 was lower than the cost in year 2

because in year 1 only provider assessment and feedback processes were established, whereas in year 2 several other interventions were added, including a provider reminder system through procedures and workflow processes and patient reminders though mailings that included FIT kits.

The strength of the current study is that interventions were delivered in the clinical practice setting of FQHCs, and therefore our experiences may be informative for other similarly structured facilities. The application at FQHCs also resulted in several potential limitations. First, the CQI initiative involved the simultaneous delivery of interventions for several chronic diseases, CRC, breast cancer and cancer screenings, and hypertension and diabetes control. In the current study, we reported only on cost-effectiveness related to CRC screening interventions and excluded potential efficiencies or deficiencies related to overall CQI initiatives. Second, we used budget and spending data to estimate cost and did not prospectively collect activity-based cost data to evaluate allocation of resources. This could lead to inaccuracies in estimation of the true cost, but we believe our retrospective assessment captured the cost accurately due to the detailed administrative data maintained by the CDPHE to track fiscal data for state and federal auditing purposes. Last, the current study was an observational study without a control group and therefore other factors, in addition to the interventions themselves, could have affected the reported increases in the CRC screening rate.

FQHCs serve disadvantaged populations who generally have low CRC screening uptake. The results of the current study demonstrated that multicomponent interventions, tailored and delivered in partnership with health system and FQHC clinic staff, increased CRC screening uptake at acceptable costs. EBIs delivered to increase CRC screening at clinics, such as those analyzed herein, may be cost-effective.

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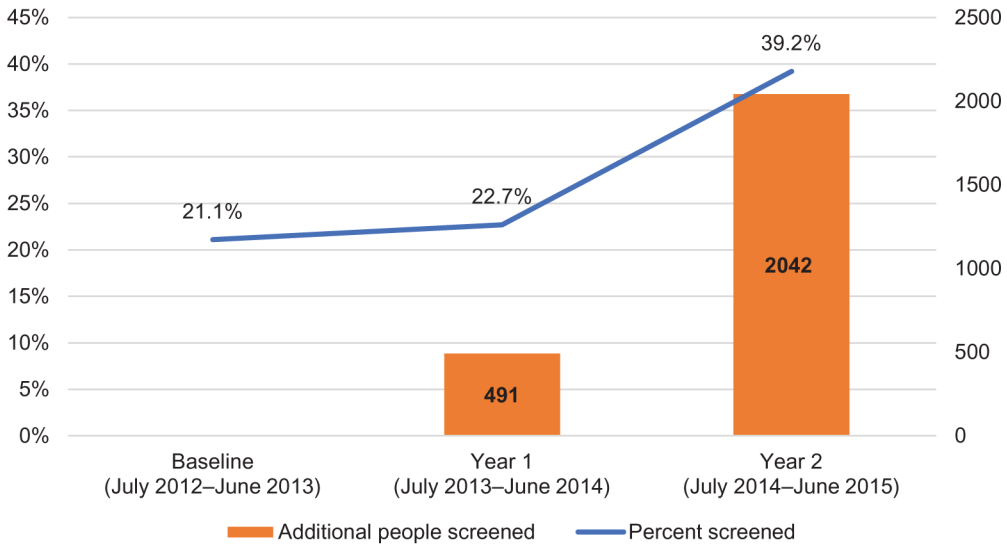

Figure 1.

Percentage screened and additional individuals screened by year for health system 1. In year 1, the provider assessment and feedback processes were established and were continued during year 2. In year 2, the provider reminder system was implemented through procedures and workflow processes and patient reminders though mailings that included fecal immunochemical test (FIT) kits.

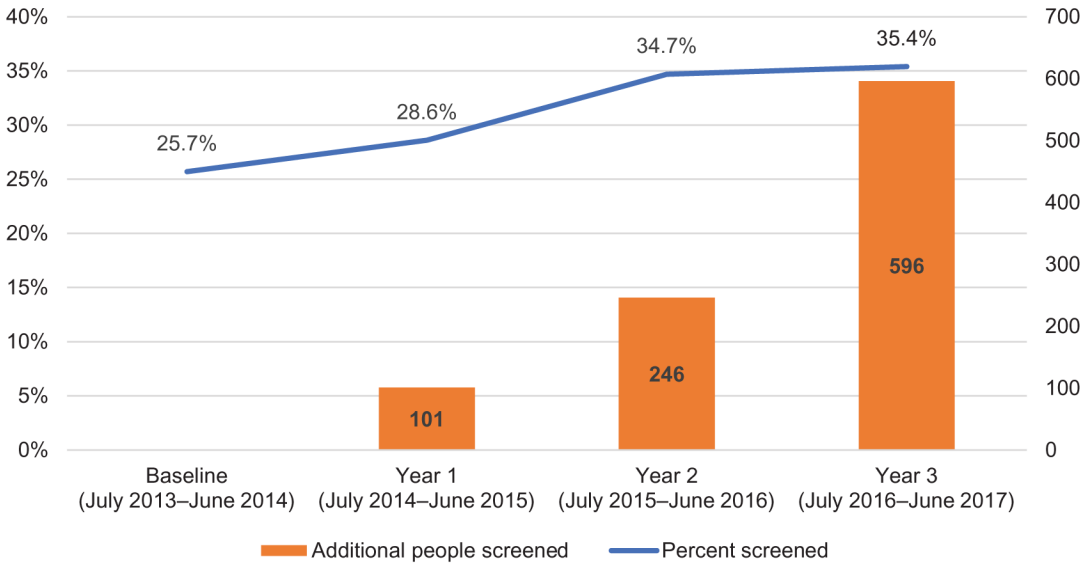

Figure 2.

Percentage screened and additional individuals screened by year for health system 2. In year 1, provider assessment and feedback processes were established and were continued in years 2 and 3. In years 2 and 3, workflow was standardized, FIT kits were offered, and patient and provider education was provided. FIT indicates fecal immunochemical test.

TABLE 1.

Effectiveness and Cost Measures for Health System 1

	Baseline (July 2012-June 2013)	Year 1 (July 2013-June 2014)	Year 2 (July 2014-June 2015)	All Years
Effectiveness measures				
Total no. screened[a]	1751	2242	4284	
Total eligible population	8313	9896	10,933	
Screening uptake	21.1%	22.7%	39.2%	
No. of additional screens	NA	491	2042	2533
Cost measures				
Total additional implementation cost, $	NA	3557	56,667	60,224
CDPHE cost[b]	NA	3557	4769	8326
Health system 1 cost[b]	NA	0	51,898	51,898
Cost-effectiveness measure				
Incremental cost per person screened, $	NA	7.24	27.75	23.78

Abbreviations: CDPHE, Colorado Department of Public Health and Environment; NA, not applicable.

[a]Number of individuals up to date with screening.

[b]Included details regarding salary and hours for staff involved in developing and implementing the interventions as well as the cost of travel, supplies, and contracts. Activity-based cost estimates were not collected and therefore costs for specific activities were not reported. The clinical costs of screening and follow-up diagnostic testing were not included.

TABLE 2.

Effectiveness and Cost Measures for Health System 2

	Baseline (July 2013-June 2014)	Year 1 (July 2014-June 2015)	Year 2 (July 2015-June 2016)	Year 3 (July 2016-June 2017)	All Years
Effectiveness measures					
Total no. screened[a]	1327	1428	1674	2270	
Total eligible population	5171	4975	4813	6421	
Screening uptake	25.7%	28.7%	34.8%	35.4%	
No. of additional screens	NA	101	246	596	943
Cost measures					
Total additional implementation cost, $	NA	821	16,300	10,376	27,497
CDPHE cost[b]	NA	821	5815	3876	10,512
Health system 2 cost[b]	NA	0	10,485	6500	16,985
Cost-effectiveness measure					
Incremental cost per person screened, $	NA	8.21	66.26	17.41	29.16

Abbreviations: CDPHE, Colorado Department of Public Health and Environment; NA, not applicable.

[a]Number of individuals up to date with screening.

[b]Included details regarding salary and hours for staff involved in developing and implementing the interventions as well as the cost of travel, supplies, and contracts. Activity-based cost estimates were not collected and therefore costs for specific activities were not reported. The clinical costs of screening and follow-up diagnostic testing were not included.