Increasing Medicaid Value by Preventing Colorectal Cancer in the Medicaid Population

An Analysis for

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Disclaimer

The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, by the University of Virginia, or by any other agency.

On my honor as a student, I have neither given nor received any unauthorized aid on this assignment.

-Joseph Alex Marchese-Schmitt

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Key Terms and Acronyms

Affordable Care Act (or ACA): The Patient Protection and Affordable Care Act, passed in 2010

CMS: United States Centers for Medicare and Medicaid

Colorectal Cancer: Cancer of the colon or rectum that develops from polyps.

FDA: United States Food and Drug Administration

GI: Gastrointestinal, relating to gastroenterology

OMB: United States Office of Management and Budget

Value (as defined by CMS): Access, price, quality, efficiency, and alignment of incentives in an insurance program[1]

Volume: The number of people covered by an insurance plan

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Executive Summary

As the second leading cause of cancer death in the United States, colorectal cancer is a serious public health issue. Since colorectal cancer is highly preventable and treatable if caught in the early stages of the disease, the level of colorectal cancer mortality in the United States is attributable to the underutilization of colorectal cancer screenings. This is especially true for the Medicaid population, which tends to utilize colorectal screenings less frequently than other insurance groups, even in states that cover these screenings with no cost-sharing or co-payment.

The Centers for Medicare and Medicaid have traditionally focused on expanding insurance in the United States, but now want to transition to increasing value for those who have public insurance. Given the prevalence and preventability of colorectal cancer, the Medicaid program has a prime opportunity to pursue its goal by increasing colorectal cancer prevention. **To increase the value of the Medicaid program, CMS should increase the number of timely colorectal cancer screenings among the Medicaid population and reduce the incidence and mortality rates of colorectal cancer.**

This report analyzes three interventions in order to identify the most cost-effective means for CMS to increase screening rates in the Medicaid population: Mailed Informational Screening Reminders (Option 1), Patient Navigation Program Grants (Option 2), and Increased Medicaid Reimbursement Rates for Visits with Gastroenterologists (Option 3). After conducting a cost-effectiveness analysis on the three options, this analysis recommends that CMS pursue Option 1: Mailed Informational Screening Reminders, since it has the lowest cost per case of colorectal cancer prevented and moderate political feasibility. After subjecting the results to a sensitivity analysis, Option 1 remained the best alternative, unless Option 2 consistently increased the accuracy of colonoscopy in locating and eliminating polyps. However, this analysis did not feel there was enough usable data on this phenomenon to take it into account in the analysis and considers Option 1 to be the most cost-effective intervention.

Finally, Option 1 has high start-up costs, and may face some resistance given the goals of the new administration. In the instance that the new administration resists Option 1, Option 2 might act as a good secondary option, since its overall costs are lower and more evenly distributed over the project timeline. Utilizing Option 2 over Option 1 will almost certainly constitute a decrease in the cost-effectiveness of intervention, however.

Introduction and Problem Statement

Traditionally, public health insurance in the United States has focused on volume. The Centers for Medicare and Medicaid have recently decided to deviate from this trend and focus on increasing the value of their programs. Though there are many avenues by which CMS could potentially pursue this initiative, there is a distinct need for greater value in colorectal cancer prevention in the Medicaid population. Currently, colorectal cancer is the second leading cause of cancer death and the third most diagnosed non-skin cancer in the United States. The American Cancer Society estimates that 50,260 people in the United States will die of colorectal cancer in 2017.[2] Given colorectal cancer is easily preventable and treatable if caught in its formative stages, the only reason for the high mortality rate is underutilization of colorectal cancer screenings. Given the especially low screening rates in the Medicaid population, Medicaid recipients are especially likely to die of colorectal cancer. **For CMS to increase the value of the Medicaid program, it should increase colorectal screening in the Medicaid population, and decrease the incidence of colorectal cancer.** The following report examines three potential interventions designed to increase colorectal cancer screenings and thus reduce colorectal cancer incidence. All three interventions are then subjected to a cost-effectiveness analysis, in order to provide CMS with the most efficient method to decrease colorectal cancer incidence in the Medicaid population.

Background and Literature Review

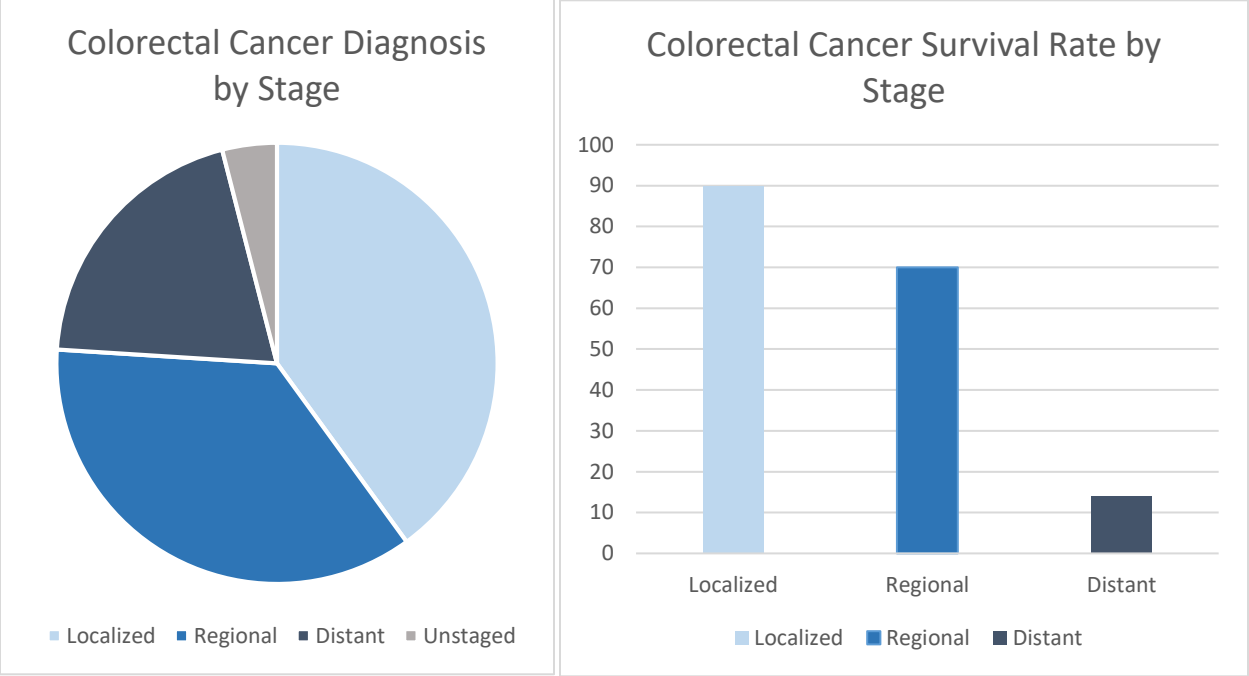
On Colorectal Cancer

Colorectal cancer is the third most diagnosed cancer and the second leading cause of cancer death in the United States.[3] According to the US Centers for Disease Control, 136,119 people in the United States were diagnosed with colorectal cancer in 2013, including 71,099 men and 65,020 women. In the same year, 51,813 people in the United States died from colorectal cancer, including 27,230 men and 24,583 women.[4] For the year 2017, the American Cancer Society estimates that 135,430 new cases of colorectal cancer will be diagnosed, and that 50,260 people will die from colorectal cancer.[5] Given the prominence and severity of colorectal cancer, it should be no surprise that there is a large body of research on the disease.

It is well-established that most forms of cancer are significantly easier to treat if they are identified at an earlier stage in their development. This is *especially* the case with colorectal cancer. Colorectal cancer typically begins as a polyp, or adenoma, in the colon or rectum.[6] On average, it takes about 10 years for a malignant polyp to become colorectal cancer, and if identified in its pre-cancerous stage, polyps are easy to remove with only rare complications.[7] If a polyp becomes cancerous, but the cancer is found early in its development (when the cancer is considered "localized"), colorectal cancer patients still have approximately 90% chance of survival. That being said, only 40% of people diagnosed with colorectal cancer are diagnosed at this stage (see figure 1). About 36% of colorectal cancer patients are diagnosed when the cancer has begun to spread, and the disease is considered "regional." At this point their survival rate has dropped to

about 70%. The next 20% are diagnosed when the disease has become distant or metastasized, and their rate of survival sharply plummets to 11%. The remaining 4% in the data from which these figures are drawn were categorized as "unstaged" for various reasons.[8]

Figure 1: Colorectal Cancer Stage Statistics



Data taken from Siegal et al, 2017[8]

Though there is no definitive evidence indicating the causes colorectal cancer, there are certain populations that are at higher risk of contracting it. Overall, men are more likely to contract colorectal cancer than women, with overall lifetime risks of 4.7% and 4.4%, respectively.[9] 87% of all people who die of colorectal cancer are above the age of 50 (see Appendix 1 for a complete breakdown of colorectal cancer death and incidence by age).[8] African Americans face significantly higher risks of contracting and dying from colorectal cancer, with 20% and 40% higher chances of being diagnosed with and dying from the disease, respectively.[10] From an equity perspective, the magnitude of this racial disparity is especially concerning. An analysis conducted by Lansdorp-Vogelaar et al in 2012, however, utilized a colon microsimulation model to estimate that 42% of the difference in colorectal cancer outcomes between blacks and whites can be attributed to differences in the frequency of colorectal cancer screenings.[11] A colorectal cancer statistical report by Siegel et al in 2017 echoes this finding, stating that 40% of the disparity can be attributed to screening differences. The report states that the remainder of the disparity can primarily be explained by disproportionate poverty levels in the black American population.[12] (In the *On the Importance of Screenings* section below, it is established that people on Medicaid and beneath the poverty line are significantly less likely to receive timely colorectal cancer screenings.) Given a significant portion of the racial disparity is caused by poverty, a significant amount of the

difference should be eliminated by increasing colorectal cancer screening rates in the Medicaid population.

The Importance of Screenings

Because colorectal cancer survival rates decrease drastically as the disease progresses, and because there is such a long window in which the disease can be detected and successfully treated before it becomes dangerous, timely screening procedures are essential in combating colorectal cancer. Fortunately, many reliable colorectal cancer screening procedures exist, including Fecal Occult Blood Tests, or FOBT, flexible sigmoidoscopy, and colonoscopy. A research survey conducted by Lansdorp-Vogelaar et al in 2012 identified that, while all of these procedures tend to be accurate and reliable, 5 out of 8 qualifying studies found 10-year colonoscopy to be the most cost-effective form of colorectal cancer screening.[13] For this reason, and because colonoscopy can remove polyps during the screening procedure, colonoscopy is often considered the "gold-standard" of colorectal screening.

Given the number of screening methods that exist, and the fact that colorectal cancer is so easily prevented but so deadly if left unchecked, one would imagine that people are diligent in pursuing some type of screening procedure. This is not the case, however. As previously cited, only 40% of the documented cases of colorectal cancer are found when they are at the localized stage, when chances of successful treatment are highest. Because so many cases of colorectal cancer are found late in their development, when mortality rate is highest, and because it is possible to detect and prevent colorectal cancer before it even becomes cancer, it becomes apparent that **the best way to reduce the mortality rate associated with colorectal cancer is to increase the rate of screening.** According to the American Cancer Society, if 80% of adults alive today were regularly screened for colorectal cancer by 2018, roughly 200,000 fewer people would die from the disease by 2030.[14]

The problem of underutilized colorectal screening is especially pervasive in the Medicaid population. According to the Minnesota Health Care Disparities report, only 53.9% of Medicaid-covered, eligible adults ages 50 to 75 were screened for colon cancer in 2015, compared to 74.3% of those covered by other types of insurance.[15] Similar trends were found in New York State, in which only 56.2% of Medicaid recipients were up-to-date on colorectal cancer screenings, while 65.4% of the privately insured population was found to be up-to-date.[16] These comparatively low screening rates are especially concerning, given all forms of preventive cancer screenings are covered by Medicaid in Minnesota and New York with no cost-sharing or co-payments. Nationally, a study by Beverly Green and Gloria Coronado from 2014 identified that, while 65% of the general population aged 50 to 75 were up to date on their colorectal cancer screenings, the same could only be said of 39% of the same demographic beneath the federal poverty line.[17] A study by Foley et al (2012) identified a similarly concerning trend: though colorectal cancer survivors are highly recommended to receive a follow-up colonoscopy after surgery, only 42% of

Medicaid recipients successfully acquired this screening.[18] Colorectal cancer is problematic nationwide, but any group with lower screening rates, like the Medicaid population, is especially at risk of unnecessary death from colorectal cancer. If CMS wants to increase the value of the Medicaid program for patients potentially at risk of colorectal cancer, it must increase the rate of preventive colorectal screenings in the Medicaid population.

For the 32 that expanded Medicaid coverage by adopting the expansion offered under the Patient Protection and Affordable Care Act passed in 2010, all preventive screenings, including those for colorectal cancer, are covered by Medicaid with no cost-sharing. Even in these states, however, Medicaid screening rates are low (significantly lower than their privately insured counterparts). This would suggest that there must be obstacles other than cost preventing the Medicaid population from receiving screenings.

Identifying Roadblocks to Screening

While it may not be immediately clear why Medicaid recipients do not take advantage of preventive screenings, there is a large pool of research that attempts to identify the issue.

One school of thought believes that the problem is largely informational. A study conducted by Florea et al in 2016 hypothesized that interventions to raise awareness, including mailed reminders, phone calls, and emails, could increase the rates of colonoscopy. The interventions were tested at three independent clinics in San Antonio, who provided the researchers with data on screening completion. After conducting pre- and post-intervention analyses, the study concluded that the interventions were responsible for a 6.3-6.9% increase in the number of screenings performed at the clinics, indicating that information deficiencies were a significant obstacle for at least some of the study's sample.[19] Similarly, a cost-effectiveness analysis by Lich et al in 2017 identified that interventions designed to increase awareness of colorectal cancer and the importance of preventive care would have significant impacts on populations that are prone to insufficient screenings. The analysis identified several possible interventions, including mailed reminders to Medicaid recipients, mass media campaigns, and the construction of additional colorectal cancer screening facilities. Through population simulations based on statistical models, the study found the mailed reminders and mass media campaigns yielded significant and cost-effective benefits.[20] The mailed reminders were especially effective at raising screening rates, and increased the up-to-date population by about 4 percentage points. These studies indicate that lack of awareness and informational deficiencies may be a significant factor behind low colorectal screening rates.

Others feel that it is not a lack of awareness that inhibits Medicaid recipients from receiving screenings, but that the issue instead stems from insufficient access to GI specialists. Though the Medicaid program has developed significantly since the ACA was passed in 2010, one of the persisting complaints about the program has been the difficulty of acquiring specialized care.[21] There is a good deal of evidence supporting these complaints. A survey by Kim et al from 2016

identified that it was significantly harder for Medicaid recipients to get an appointment with foot and ankle specialists than it was for those with other types of insurance, and that wait times tended to be longer for Medicaid patients.[22] A survey of orthopedic offices by Skaggs et al from 2006 identified that children with Medicaid coverage had a significantly harder time scheduling an appointment and receiving care. While this survey is a little outdated (since it was conducted before the passage of the ACA) and the main findings should be taken with a grain of salt, it is not without value: the researchers behind this study analyzed the survey responses, and found a significant correlation between the regional reimbursement rates offered by Medicaid and the willingness of offices to take Medicaid patients.[23] This is significant, since Medicaid still tends to reimburse less per procedure than other forms of insurance.[24]

Gastroenterologists (who perform colorectal screenings) are not exempt from these access barriers. According to a 2012 survey conducted by Patel et al, 47% of gastroenterologists across the nation identified that they were not planning to accept any additional Medicaid recipients into their practice. This is concerning, given that the Medicaid population grew by 18,173,405 individuals in 2016.[25] The first Patel survey was followed by a "secret shopper survey" conducted in Connecticut, in which researchers called gastroenterologists under the guise of patients seeking screenings. Half of the calls were made as if the patient was a Medicaid recipient, while the other half was made as if the patient was privately insured. Only 62% of the gastroenterologists called reported Medicaid participation, with lower rates in smaller counties. Though the study found that there was not enough evidence to determine whether there was a definitive shortage of gastroenterologists relative to the Medicaid population, it did not rule out the possibility of barriers to access due to supply and demand imbalances.[26] It is distinctly possible that access issues are a significant factor behind the low rates of colorectal screenings by Medicaid recipients, and these access issues may exist because of low reimbursement rates.

Strategies for Increasing Screenings

The literature indicates that the obstacles preventing the Medicaid population from receiving timely colorectal cancer screenings are the product of deficiencies in information and access. If the obstacles are informational, there are many interventions that could be used to overcome them by raising colorectal cancer awareness. Among these interventions, mailed screening reminders stand out as a particularly well-studied option. As cited earlier, a study by Florea et al from 2016 demonstrated that mailed reminders could successfully increase screening rates as part of a bundled informational intervention. Another study by Lee et al from 2011 conducted a controlled-observational trial, in which mailed informational reminders were found to increase an individual's likelihood of receiving a colorectal cancer screening by 16.2%.[27] Another study by Lewis et al in 2011 utilized a controlled trial and found mailed reminders led to an 11 percentage point increase in colorectal cancer screening likelihood.[28] Mailed informational reminders have been established as an effective way to increase colorectal cancer screenings in populations that underutilize these screenings.

If the obstacles are the result of an access deficiency, they can be addressed by a different set of interventions. A commonly studied solution to access deficiencies in Medicaid is increased Medicaid reimbursement rates. Currently CMS reimbursements to physicians are on average only 60% of the reimbursements provided by private insurance.[29] This lower reimbursement rate is believed to be the reason many physicians do not accept Medicaid patients, thus creating a shortage of physicians willing to serve the Medicaid population. Increasing Medicaid reimbursement rates may help offset this access issue. A study by Polski et al examined the Medicaid fee bump of 2013-14, in which Medicaid reimbursement rates for general medicine visits were raised by the ACA to match the reimbursement rates provided by Medicare. The study found the fee bump led to mixed results. Though the bump failed to attract any new providers to serve the Medicaid population, it did increase the number of Medicaid patients accepted by providers that already accepted Medicaid by about 5 percentage points of the Medicaid population, mitigating the access deficiency at least marginally.[30]

One potential solution that could address both informational and access barriers is the institution of a patient navigation program. Under patient navigation, general practice settings are used to connect patients to specialized care by employing general medicine staff (patient navigators) to help patients schedule appointments with specialists who accept their insurance coverage. A patient navigation program would help offset informational deficiencies by putting Medicaid recipients in contact with knowledgeable healthcare workers, who could explain the importance of colorectal screening. A patient navigation program would also eliminate the difficulty of locating a specialist who accepts Medicaid coverage, thereby addressing the access issue by matching eligible patients with available specialists. A controlled-observational study by Elkin et al in 2012 found that a patient navigation program can increase the number of colorectal screenings per hospital per year by between 500 and 800 screenings.[31] Patient navigation programs may provide a solution to both informational and access barriers.

Stakeholder Analysis

Centers for Medicare and Medicaid

The Centers for Medicare and Medicaid have announced that they want to shift the emphasis of their programs from volume to value. Since colorectal cancer is a serious threat to public health that can be simply addressed through interventions to increase screenings, increasing colorectal cancer prevention is an efficient way for CMS to work towards its goal. All three of the interventions analyzed in this report offer a great deal of value to the Medicaid program by incentivizing timely colorectal screenings, thus leading to better health outcomes in the Medicaid population. By pursuing the most cost-effective alternative, CMS should be able to increase the value of its Medicaid program while minimizing the costs to society.

Medicaid Recipients

Medicaid recipients are the major beneficiaries of all three potential interventions, and have the most to gain of all the stakeholders. No matter which of the three policies CMS decides to pursue, screening frequencies are expected to increase for Medicaid recipients, and this should yield significant decreases in colorectal cancer incidence and mortality among the Medicaid population.

Physicians/Gastroenterologists

Physicians and gastroenterologists have a significant stake in the intervention that CMS decides to pursue, as each intervention will affect their business prospects differently. In the case of the options presented in this report, Option 2 should appeal most to general practice physicians, as a Patient Navigation Program Grant would direct CMS funds to general practice settings (namely, hospitals). Gastroenterologists, on the other hand, would most likely support Option 3: Increased Reimbursement Rates for Gastroenterology Visits, as increased gastroenterology reimbursement rates for Medicaid recipients would increase the number of financially viable patients for gastroenterologists to serve at their practice.

Data Analysis Methodology

This analysis seeks to identify the intervention that CMS can utilize to most efficiently increase the prevention of colorectal cancer in the Medicaid population. This objective lends itself well to a *cost-effectiveness analysis.* In this cost-effectiveness analysis, the impacts and costs of three colorectal screening interventions will be examined, in order to compare the cost per case of colorectal cancer avoided under each intervention. The final recommendation will be chosen in part based on the outcome of this analysis.

In this cost-effectiveness analysis, all interventions are treated as ten-year programs administered by CMS at a national level. All costs and effects of each intervention that take place after the first year of the intervention will be subject to simple, annual discounting. The discount rate was 3%, as is recommended by OMB circular A-4.[32] When calculating costs and effects, only those effects that will occur *in addition* to the status quo will be calculated. This is to say that if a cost or effect would occur without the intervention, it will not be included in calculations.

A cost faced by all interventions is the cost of additional colonoscopies. Given the market price of colonoscopy is highly variable across the United States (with values ranging from $1000[33] to $3000[34]) a middle range of $2000 was chosen for the sake of this analysis.

Though the Policy Options and Cost-Effectiveness Analysis section below will present general overviews and results of all calculations made, the Technical Appendix (found in Appendix 3) can be referenced to see specific breakdowns of all calculations made, as well as all assumptions made in order to perform the analysis.

Evaluative Criteria

Several criteria will be used to evaluate the interventions examined in this study. Quantitative criteria, including costs to society, number of cases of colorectal cancer, and number of additional colonoscopies, will be used in the cost effectiveness analysis to determine the efficiency of each option. The sole qualitative criteria utilized in this analysis will be political feasibility, which will represent the ease with which any of these interventions can be executed. Each criterion is explained in detail below.

Costs to Society:

When describing cost, this analysis describes the "cost to society" or the "social cost," rather than just the cost to CMS, under the assumption that government agencies are more concerned with societal well-being than they are with government expenditures in a vacuum. As such, cost calculations include expenditures that are not born directly by CMS. For example, even though CMS only tends to reimburse a portion of the cost of every additional colonoscopy, the full market price of colonoscopy will be used when calculating the cost of additional colonoscopies generated by an intervention.

It is also worth noting that all costs will be calculated in contrast to the status quo. This is to say that if a cost would have been generated even if the intervention was not employed, this cost will not be included in the cost-effectiveness analysis. In this vein, a key assumption made by this analysis is that all polyps that have become cancerous by the time a patient receives his/her first colonoscopy would have been found anyway. As such, the cost of cancer treatment is assumed to be part of the status quo, and will not be included in any of the cost-effectiveness calculations.

Every intervention has its own distinct cost categories, since every intervention is fundamentally distinct. These cost categories will be discussed in depth in the Policy Options and Cost-Effectiveness Analysis section. The only cost category included in all the options is the cost of additional colonoscopies, as the purpose of each option is to generate additional colonoscopies in the eligible Medicaid population, and thus prevent colorectal cancer.

As mentioned earlier, every option was treated as if it would be part of a ten-year intervention. All costs utilized in this analysis were discounted at a 3% yearly discount rate, as is recommended for government programs by the US Office of Management and Budget circular A-4.[35]

Number of Cases of Colorectal Cancer:

The end goal of each of the included interventions is to increase colorectal cancer prevention in the Medicaid population. As such the number of cases of colorectal cancer prevented, or the number of fewer cases of colorectal cancer when compared to the status quo, will be the main effectiveness measure for the interventions in this analysis.

Though the number of cases of colorectal cancer prevented by each option will be the primary effectiveness measure of this analysis, the source literature rarely presents effectiveness in this form. Instead, it is much more likely that other studies present findings in the form of "additional colonoscopies." To find the number of cases of colorectal cancer prevented from the expected increase in colonoscopies, the expected increase in colonoscopies was multiplied by the rate at which colonoscopy finds and eliminates all polyps (estimated to be 70%[36]) and then multiplied by the lifetime risk of colorectal cancer for an individual at the age of 50[37]. In doing so, this analysis translates the expected increase in colonoscopies to the number of polyps found and removed by colonoscopy that would have become cancerous (in other words, the number of cases of colorectal cancer avoided).

Number of Additional Colonoscopies:

Though the number of additional colonoscopies generated by an option is not the core effectiveness measure of this analysis, the number of additional colonoscopies generated by each intervention is key in determining how many cases of colorectal cancer will be prevented by an intervention.

See previous section for the equation used to translate the number of additional colonoscopies to the number of colorectal cancer cases.

Qualitative Criteria: Political Feasibility

While the options will primarily be measured against each other in a quantitative cost-effectiveness analysis, there are often factors that do not fit into a cost effectiveness analysis that still merit consideration. In the case of this analysis, political feasibility is an important consideration in addition to the results of the cost-effectiveness analysis. The 2016 election cycle resulted in a Republican-controlled Presidency and Congress, both of which have announced plans to cut healthcare spending and repeal the Affordable Care Act. Each intervention is expected to be met with variable degrees of resistance by the new administration, making political feasibility an important consideration when choosing an intervention.[38]

Policy Interventions and Cost-Effectiveness Analysis

This analysis seeks to identify the most efficient intervention CMS can employ to increase colorectal cancer prevention in the Medicaid population. This objective lends itself well to a cost-

effectiveness analysis. To see the specific calculations performed by this analysis, see Appendix 3: Technical Appendix.

Option 1: Mailed Reminders to Medicaid Recipients

Option 1 Summary

Summary of Option 1: Mailed Informational Reminders				
Aggregate Cost	Aggregate Additional Colonoscopies	Expected Number of Cases of CRC Avoided	Cost Effectiveness of Intervention (Dollars per case of CRC Avoided)	Political Feasibility*
$10,000,000,000	**5,000,000**	**160,000**	**$62,000**	**2**
*Political Feasibility Key can be found in Figure 2: Outcomes Matrix				

Description

If the major obstacle preventing Medicaid recipients from receiving colorectal screenings is information deficiency, one possible solution is to mail screening reminders to Medicaid recipients who are eligible or overdue for screening. According to recommendations by the U.S. Centers for Disease Control and Prevention, it is recommended that an individual receive a colonoscopy once every ten years between the ages of 50 and 75 years old.[39] Under this intervention, CMS should create a national database to actively track the age, home address, and last colonoscopy of all Medicaid recipients (currently, CMS primarily relies on state databases, and most data tends to be outdated). This database will be used to mail Medicaid recipients an informational brochure, detailing the risks of colorectal cancer, the benefits of screening, and how to find a gastroenterologist nearby to schedule a colonoscopy. Since the individuals recommended for colonoscopy by the CDC are aged 50 to 75, it is important that the reminders be physical, mailed brochures, rather than electronic reminders, to ensure that the reminder reaches its target audience. This brochure will be mailed out by administrative assistants under the Department of Health and Human Services to all Medicaid recipients turning 50, 60, and 70. The reminder will also be sent to all new Medicaid recipients over the age of 50 (and then ten years after, until age 75), under the assumption that new enrollees are not up-to-date on screenings. The reminder would provide all key information in both English and Spanish.

Cost to Society:

There are many costs attached to the mailed informational reminder intervention. The first is the cost of developing the reminder content. This value was determined to be a one-time cost of $1000 as an assumption by the analyst. The next necessary cost was the creation of a national database, to track the mailed reminders sent to each Medicaid recipient, as well as the age and address of each recipient. The cost estimate for this database was based on the cost of a similar national database designed for the FDA, which cost approximately $67,000,000.[40] There is also a cost affiliated with database maintenance, which was estimated to about $50,000 yearly, based on an OMB analysis of an FDA database of similar scope.[41] The cost of materials and postage was

estimated to be a yearly cost of $15,000,000, based on the cost of postage and materials assumed by the analyst and the number of reminders that would need to be sent out in a given year. Cost of time to prepare and mail reminders was calculated based on the number of reminders that would need to be sent per year, the assumed number that could be prepared and sent per hour, and administrative assistant hourly wage rate, giving a yearly cost of $7,500,000. Costs of additional colonoscopies were found by multiplying the expected increase of colonoscopy (found in *Effectiveness*) by the assumed market price of colonoscopy, giving a yearly cost of about $1,100,000,000. All costs that took place after year one were simply discounted with a yearly rate of 3%. The aggregate cost of a ten year intervention was calculated to be $10,000,000,000.

Effectiveness:

Based on studies by Lee et al all from 2012, Florea et al from 2016, and Lewis et al from 2011, it was estimated that receiving a mailed reminder would increase one's likeliness to receive a colorectal cancer screening by approximately 10%. The number of additional colonoscopies generated was calculated by multiplying this increased likelihood by the number of individuals eligible to receive a reminder then multiplied by the assumed percentage of reminders that reached their intended recipient (estimated at about 75%, given the general transience of low-income people). It was calculated that Option 1 would generate an additional 560,000 colonoscopies per year, for a total of 5,000,000 additional colonoscopies over the course of the ten-year intervention, after applying proper discounting.

The number of colonoscopies generated by the intervention was then multiplied by the effectiveness of colonoscopy at identifying and removing polyps and the lifetime risk of colorectal cancer for a person at age 50 to find the total number of colorectal cancers prevented by this intervention. Option 1 was found to prevent 160,000 cases of colorectal cancer over the course of ten years.

Political Feasibility:

Currently, the Centers for Medicare and Medicaid issue several forms of reminders for varying purposes.[42] Even though these reminders tend to be virtual/electronic and not physical, there should be no political restrictions preventing CMS from mailing physical reminders to Medicaid recipients to remind them that they are overdue for a colorectal screening. To be enacted, all this intervention would require is funding. That being said, the funding required for this intervention is substantial, which might reduce this option's political feasibility.

Option 2: Patient Navigation Program Grant for Colorectal Screening

Option 2 Summary:

Summary of Option 1: Mailed Informational Reminders				
Aggregate Cost	Aggregate Additional Colonoscopies	Expected Number of Cases of CRC Avoided	Cost Effectiveness of Intervention (Dollars per case of CRC avoided)	Political Feasibility*
$4,200,000,000	**1,900,000**	**62,000**	**$68,000**	**1**
*Political Feasibility Key can be found in Figure 2: Outcomes Matrix				

Description:

If access to specialists is a significant roadblock to Medicaid recipients receiving timely colorectal screenings, it may be because there is a deficiency in gastroenterologists that accept Medicaid coverage. Under these conditions, finding a gastroenterologist and scheduling a timely screening can be difficult and inhibitive. A Patient Navigation Program could reduce or eliminate this disincentive. Under a Patient Navigation Program, nurses or secretaries in hospitals designated as "Patient Navigators" are instructed to identify patients eligible or overdue for a colorectal screening. Once patients are identified, these Navigators sit down with the patients, explain the importance of screening, and help them make colonoscopy appointments at specialist locations that accept Medicaid-based insurance. In doing so, a Patient Navigation Program eliminates the costs of time and energy that are associated with finding a gastroenterologist that accepts Medicaid coverage, leaving the patients only responsible for attending and properly preparing for the procedure itself. This intervention recommends that CMS create a grant to be designated to hospitals on the condition that they establish a Patient Navigation Program specifically designed to increase colorectal cancer screening for eligible Medicaid recipients.[43]

A Patient Navigator Program Grant would be funded by CMS, but organized on a hospital by hospital basis. As a result, the scope of the program is the direct product of how many hospitals CMS chooses to fund. The number of hospitals funded is a function of the size of the individual grants issued and the budget designated to supply these grants.

Costs to Society:

The costs of a Patient Navigator Program Grant are fairly straightforward. The primary cost is the budget outlay that will determine how many grants can be issued. Given this program has minimal startup or delayed costs, the budget for this program can be expanded or contracted without any effect on the cost-effectiveness of the intervention, meaning that for the purpose of this analysis (which focuses on cost-effectiveness) the number selected for the total budget is not instrumental. A $50,000,000 budget was used for calculations in order to adjust the raw costs and effects of this option to a scope that is easy to compare to the other options without being politically unrealistic.

The other major cost to society of Option 2 is the cost of additional colonoscopies generated by this intervention. This cost was generated using estimated impacts of patient navigation taken from the literature (see *Effectiveness* section) and the market price of colonoscopy. Total cost of additional colonoscopies was calculated to be about $430,000,000. The aggregate cost of the intervention was calculated to be about $4,200,000,000, with proper discounting applied.

Effectiveness:

According to a controlled, observational analysis conducted by Elkin et al, the establishment of a colorectal screening patient navigation program led to an additional 500 to 800 additional colonoscopies per year.[44] For the purpose of this analysis an intermediate value was selected, and it was assumed that every hospital given a grant would generate an additional 650 colonoscopies per year.

The number of total colonoscopies funded by this intervention was generated using two assumptions. The first was the budget assumed for colorectal cancer interventions (discussed in the *Costs to Society* section above). The second, and more important, assumption was the salaries of the workers administering the patient navigation. Elkin et al identified navigator salaries to range from $104,000 to $300,000 per year, with variation depending on expertise and the paygrade of the people running the program. For the purpose of this analysis, it was assumed that the system would be administered by some combination of secretaries and nurses, and that the costs of yearly salaries for patient navigation would be $150,000 per hospital. The grant size was set to match this amount at $150,000 per participating hospital. The assumed CMS budget for colorectal cancer interventions was then divided by the size of each grant in order to find the number of hospitals the intervention could fund. Given a budget of $50,000,000 per year, it was found that 333 could be funded. According to the previous assumption that every hospital would generate an additional 650 colonoscopies per year under a patient navigation system, the 333 hospitals funded by Option 2 would generate an additional 216,000 colonoscopies per year, resulting in 1,900,000 additional colonoscopies when treated as a ten-year program with proper discounting.

The number of colonoscopies generated by the intervention was then multiplied by the effectiveness of colonoscopy at identifying and removing polyps and the lifetime risk of colorectal cancer for a person at age 50 to find the total number of colorectal cancers prevented by this intervention. Option 2 was found to prevent 62,000 cases of colorectal cancer over the course of ten years.

Political Feasibility:

A Patient Navigation Grant for Colorectal Screenings should have no political feasibility issues. Currently, the Centers for Medicare and Medicaid offer several grants, some of which are even designated specifically for the establishment and support of similar navigation programs.[45] While the success of this option hinges on the event of hospitals actually applying for the grants, this analysis assumes that there will not be a shortage of applications to choose from when selecting hospitals to fund. All that this intervention would require to be enacted is funding. Because this

option has a flexible funding model and can be adjusted to scale without sacrificing cost-effectiveness, the political feasibility of this option is high.

Option 3: Increase Medicaid Reimbursement Rates for Visits with Gastroenterologists

Option 3 Summary:

Summary of Option 1: Mailed Informational Reminders				
Aggregate Cost	Aggregate Additional Colonoscopies	Expected Number of Cases of CRC Avoided	Cost Effectiveness of Intervention (Dollars per case of CRC avoided)	Political Feasibility*
$17,000,000,000	**6,900,000**	**230,000**	**$74,000**	**3**
*Political Feasibility Key can be found in Figure 2: Outcomes Matrix				

Description:

Another way to address potential issues with access is to increase reimbursement rates for Medicaid covered procedures. Low reimbursement rates have been identified as a significant factor contributing to the potential shortage of specialists that serve the Medicaid population.[46] By increasing the Medicaid reimbursement rates for GI visits to match the reimbursements used by private insurance, Medicaid recipients will be just as viable for gastroenterologists as individuals with other types of insurance. This should lead to an increase in the accessibility of GI services provided for Medicaid recipients, including colorectal screenings.

Costs to Society:

The primary cost associated with this option is the cost of additional gastroenterology visits that would result from the increased reimbursement rates. The cost of each visit was estimated to be about $420, based on the national average market price.[47] To find the total cost of additional visits, the market price of a GI visit was multiplied by the number of additional GI visits (examined in the *Effectiveness* section). The total cost of additional visits was found to be $330,000,000 per year.

The other major cost of Option 3 was the cost of additional colonoscopies. To calculate this, the number of colonoscopies (calculated in the *Effectiveness* section) was multiplied by the price of colonoscopy to find a cost of approximately $1,500,000,000 per year. When all costs were combined, Option 3 was found to have an aggregate cost of $17,000,000,000 for the ten-year intervention, after proper discounting was applied.

Effectiveness:

The number of additional visits was estimated based on the analysis of the fee bump conducted by Polski et al in 2015[48], which found that an increase in reimbursement rates would lead physicians that currently accept Medicaid to expand the number of patients they serve. This heightened accessibility was estimated to result in a 5 percentage point increase in screening rates. To calculate the total number of additional visits, the expected increase in screening rates was multiplied by the number of people in the Medicaid population eligible for a colonoscopy, resulting in an additional 780,000 visits every year. Under the assumption that every additional visit under this intervention led to an additional colonoscopy, this intervention was found to lead to an additional 780,000 colonoscopies per year, or about 6,900,000 additional colonoscopies in ten years.

The number of colonoscopies generated by the intervention was then multiplied by the effectiveness of colonoscopy at identifying and removing polyps and the lifetime risk of colorectal cancer for a person at age 50 to find the total number of colorectal cancers prevented by this intervention. Option 3 was found to prevent 230,000 cases of colorectal cancer over the course of a ten-year intervention.

Political Feasibility:

This option may run into some trouble with political feasibility. Although increased reimbursement rates are not unprecedented, they typically require legislative authorization. The Medicaid Fee Bump discussed earlier was enacted under section 1202 of the ACA, and was merely carried out by CMS.[49] For CMS to pursue this option, it would require legislative authorization in addition to funding. Given the announced goals of the new administration to cut healthcare costs, legislative authorization is unlikely.[50]

Analysis Results:

The outcomes matrix below (figure 2) shows a summary of the analysis conducted above. Figure Y shows graphical representations of the findings presented in the outcomes matrix.

Figure 2: Outcomes Matrix

		Evaluative Criteria for a 10 Year Screening Intervention Program				
		Aggregate Cost	Aggregate Additional Colonoscopies	Expected Number of Cases of CRC Avoided	Cost Effectiveness of Intervention (Dollars per case of CRC avoided)	Political Feasibility*
Options	Option 1: Reminders	**$10,000,000,000**	**5,000,000**	**160,000**	**$62,000**	**2**
	Option 2: PNP Grant	**$4,200,000,000**	**1,900,000**	**62,000**	**$68,000**	**1**
	Option 3: Higher Rates	**$17,000,000,000**	**6,900,000**	**230,000**	**$74,000**	**3**

*Political Feasibility Key

1: Option is similar to a current practice, and would only require funding to execute. Funding required is flexible, or comparatively low.

2: Option is similar to a current practice, and would only require funding to execute. Funding required is inflexible and comparatively moderate to high.

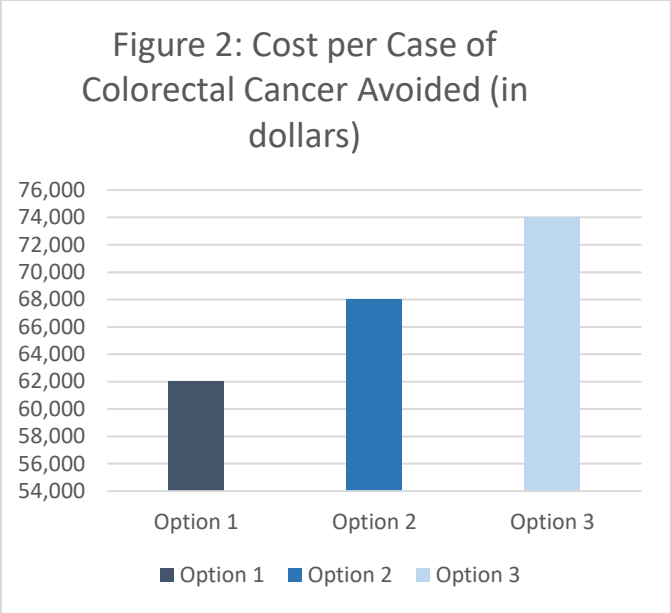
3: Option has precedent, but is not currently practiced, and would require legislative authorization and funding to execute. Funding required is comparatively high.

Discussion

The cost-effectiveness analysis conducted above finds Option 1: Mailed Informational Reminders to have the most efficient cost-effectiveness at approximately $62,000 per case of colorectal cancer avoided seen in Figure 2. Option 2 follows close behind with a cost-effectiveness of $68,000 per case of colorectal cancer avoided, and Option 3 turns out to be the least efficient option, with costs of $72,000 per case of colorectal cancer avoided. By the standards of this cost-effectiveness analysis, Option 1 is the best option.

Of the three options, Option 3 yields both the highest costs and the highest number of cases of colorectal cancer prevented, at $17,000,000,000 and 230,000, respectively. Though Option 3 possesses the highest number of cases of cancer prevented overall, this is not significant, since Option 2 has a higher cost-effectiveness and can be adjusted to scale without altering the cost-effectiveness. This is to say that if Option 2 were given the budget of Option 3, it would produce a higher number of colorectal cancer cases avoided than Option 3. Option 3 is completely outclassed by Option 2. To see graphical representations of Aggregate Costs and Effects, see Appendix 2.

In terms of political feasibility, Option 2 is the most viable, since it can not only be executed by CMS without legislative authorization, but also because it can be adjusted to scale without sacrificing efficiency—an important criterion when working under an administration dedicated to cutting healthcare costs. Option 1 is slightly less politically feasible than Option 2. Though Option 1 also has precedent, and can also be carried out without legislative authorization, the sizable, fixed budget associated with Option 1 may make it unfavorable under the scrutiny of the new administration. Finally, Option 3 is easily the least politically feasible option, as it is very unlikely that legislative approval would be granted for such a large expenditure under the current political climate.



Justifying Costs

At first glance, all of these interventions may seem expensive. Even in the most cost-effective case, it costs $62,000 to avoid one case of colorectal cancer. Though this analysis did not conduct a benefit-cost analysis (to determine that the benefits of these interventions outweigh the costs) a quick, back-of-the-envelope calculation easily justifies this expense. According to a report by US News, the average cost of cancer treatment per month is approximately $10,000, with some treatments ranging up to $30,000.[51] Given the lower bound of this cost, avoiding 6 months of cancer treatment by preventing a case of colorectal cancer altogether justifies the cost of the intervention. Give the higher bound of these costs, avoiding only 2 months of cancer treatment by preventing colorectal cancer justifies the cost of the intervention. This quick calculation does not take into account other key cost categories affiliated with cancer, including the pain and suffering that comes with the disease and the necessary treatments, as well as the value of statistical lives saved by avoiding cancer death through prevention. With all these costs in mind, it is highly likely that the costs avoided via the prevention of colorectal cancer through these interventions justifies the costs of the interventions themselves.

Sensitivity Analysis

Though all of the data used in this analysis was taken from reputable academic sources, many of the final numbers used in calculation were middle ranges, or were chosen as an assumption. In order to ensure the best possible option be pursued, it is necessary to conduct a

sensitivity analysis, and see if any of the other options become the most cost effective if values are altered within reasonable parameters.

The *Discussion* section above establishes that Option 1 is the most cost-efficient option followed by Option 2. It also establishes that Option 3 is entirely outclassed by Option 2, since Option 2 is more cost-efficient, and can be adjusted to scale, and since Option 3 has very low political feasibility under the current political climate. For this reason, the below sensitivity analysis only analyzes the categories that would affect the relative cost-efficiencies of Options 1 and 2.

The first sensitivity analysis table below (table 1) presents the values utilized in the cost-effectiveness analysis for several key categories. Beside these values is the reasonable range of values (taken from source literature) that could have been used in the analysis. For example, take the "Cost of Material and Postage for one reminder" category. According to the below table, the value used for this category was $2.00, but it could have reasonably been as high as $3.00, or as low as $1.00.

Table 1: Key Sensitivity Categories Altering Relative Cost-Effectiveness	Used Value	Reasonable Range
Effectiveness of Colonoscopy in deterring colorectal cancer under option 2 (Option 2)	70%	Unknown
Cost of Hospital Salaries to Administer Patient Navigation System (Option 2)	$150,000.00	$100,000 to $250,000
Number of Additional Colonoscopies per hospital from Patient Navigation (Option 2)	650.00	500 to 800
Increased likelihood of receiving screening after receiving reminder (Option 1)	10%	8% to 12%
Percent of Reminders expected to reach their recipient through USPS (Option 1)	75%	50% to 85%
Cost of Materials and Postage for one reminder (Option 1)	$2.00	$1.00 to $3.00

The table below (table 2) tests the sensitivity of the cost-effectiveness analysis performed in this analysis by adjusting all the used values and recalculating the cost per case of colorectal cancer avoided according to these new values. In the table below, all the values were chosen such that they would maximize the cost-effectiveness of Option 2, while minimizing the cost-effectiveness of Option 1. In other words, all values were manipulated within reasonable bounds to favor Option 2.

Table 2: Key Cost-Effectiveness categories	New Value
Effectiveness of Colonoscopy in deterring colorectal cancer under option 2	70%
Cost of Hospital Salaries to Administer Patient Navigation System	$100,000.00
Number of Additional Colonoscopies per hospital from Patient Navigation	800.00
Increased likelihood of receiving screening after receiving reminder	8%
Percent of Reminders expected to reach their recipient through USPS	50%
Cost of Materials and Postage for one letter	$3.00
Option 1: Mailed Reminder Outcomes	New Value
Total Costs:	$ 5,633,023,454.03
Total Additional Colonoscopies:	2,650,277.69
Total Cases of Colorectal Cancer Avoided:	87,194.14
Cost Effectiveness (Cost per CRC Avoided):	**$64,603.24**
Option 2: Patient Navigation Program Overview	New Value
Total Costs:	$746,819,258.36
Total Additional Colonoscopies:	351,444.36
Total Cases of Colorectal Cancer Avoided:	11,562.52
Cost Effectiveness (Cost per CRC Avoided):	**$64,589.67**

According to the calculations run in table 2, even in extreme situations (that remain within the reasonable bounds established by the literature) Option 1 will at least be about as cost-efficient as Option 2. This is to say that, in terms of cost-effectiveness, **Option 1 is the dominant option.**

There is one exception, however. It must be noted that, in table 2, the "Effectiveness of Colonoscopy in deterring colorectal cancer under option 2" category is set at 70%. At 70%, this success rate is the same as the standard colonoscopy. A study by Lebwohl et al from 2014, however, suggests that patient navigation does not only increase the number of colonoscopies, but **also the quality of colonoscopy preparation**. It is well-established that increased colonoscopy preparation increases the ability of the colonoscopy to find and eliminate polyps, increasing its efficacy at deterring colorectal cancer.[52] No other studies on patient navigation identified by this analysis examine whether or not patient navigation increases quality of colonoscopy preparation, or even identify this increase in quality as a possibility. Furthermore, the study by Lebwohl et al does give clear results on how likely patient navigation is to increase the quality, or how much this increase in preparation might affect colonoscopy quality. For this reason, this supposed increase in preparation quality and its effects were not considered in the cost-effectiveness analysis or sensitivity analysis used in this analysis. It is worth noting however, that only an 8 percentage point increase in the ability of colonoscopy to find and remove polyps under a patient navigation

program would make Option 2 more cost-effective than Option 1. Additionally, under the scenario presented in table 2, it would only take a 1 percentage point increase in the ability of colonoscopy to find and eliminate polyps under patient navigation to make Option 2 more cost-effective than Option 1.

Limitations

For the purpose of this analysis, it is assumed that all polyps that become colorectal cancer would have demonstrated symptoms of some type, and that people who receive colonoscopies during the window of this intervention, but who had cancer prior to this colonoscopy, would have gotten the colonoscopy regardless of this intervention. As such, the screenings received by these people are not considered a result of the intervention, and the cost of their cancer treatment is not considered in the cost of these interventions. However, it is likely that some people would not notice the symptoms of their cancer, or not have notable symptoms. There is no data that could describe how many cases like this would occur, and it was omitted from analysis. In practice, it is possible that the costs affiliated with each intervention would be higher than described here, as the cost of each intervention would also need to include the cost of cancer treatment for these people. While costs would shift upward in this scenario, it is also worth noting that each intervention could be attributed with more lives saved as well.

As described earlier in this analysis, all values for the cost-effectiveness analysis were taken from other academic studies. These other studies were all peer-reviewed and were often highly cited, but as is the case for all academic work, the integrity of this analysis depends on the integrity of its source material, and the findings of this analysis are only so accurate as the findings of its sources. Additionally, any limitations or errors represented in the source studies also carry on into this analysis. The sensitivity analysis above finds that Option 1 is at least as efficient as the next best option. If the reasonable ranges for each sensitivity category (which are taken from the source studies) are inaccurate, the sensitivity analysis will be inaccurate as well, opening up the possibility for other options to be more efficient than Option 1.

Additionally, this analysis assumes (as do many of the source studies), that if given the information about the importance of timely colorectal screenings, and the ability to get a colorectal screening, that eligible people will get them. This may not be the case, however. There is anecdotal evidence that suggests that many people, especially men, have a psychological aversion to invasive procedures like colonoscopies. While this aversion was not taken into account into in this analysis, it may be worthwhile for future analyses to incorporate the possibility of this aversion into their findings.

Recommendation:

This study finds that Option 1 has better cost-effectiveness than the other two options examined by this analysis, and a moderate level of political feasibility. Given these findings, this

analysis considers Option 1 to be the most efficient *and* feasible option included in this analysis, and believes that this option will provide the best opportunity for CMS to increase colorectal cancer prevention in the Medicaid population, and thus increase the value of the Medicaid program. This analysis recommends that the Centers for Medicare and Medicaid pursue Option 1: Mailed Informational Reminders.

Implementation

The first step to implementing Option 1: Mailed Informational Reminders is to develop a federal database that tracks the age and address of Medicaid recipients, as well as the date of the most recent reminder mailed to each recipient and, ideally, the date of the recipient's last colorectal screening. Because Medicaid is run on a state-by-state basis, there is not currently a federal database that is both up-to-date and detailed enough to meet the needs of this intervention. Once the database is established, data on recipients should be taken from relevant databases at the state level. All information that cannot be attained (it is possible that some states will not have data on Medicaid recipients' colorectal screening status, for example) should be collected as the program is implemented. Great care should be taken to ensure that the data collected does not violate patient privacy laws. Every year the database should be updated based on state databases, in order to keep addresses (and hopefully screening information) up-to-date.

As the database is established, the content to be included in the reminder will need to be developed. The reminder itself should be highly detailed, and should resemble a decision aid brochure, including information on 1.) the risks of colorectal cancer 2.) the effectiveness of colorectal screenings at deterring colorectal cancer 3.) how a Medicaid recipient should go about making an appointment for the desired screening. Ideally, this brochure will be double-sided, and contain all of this information in English on one side, and in Spanish on the other. The materials used in creating the brochure should be selected in order to minimize costs without sacrificing the impact of the information contained.

Finally, the reminders will need to be sent to eligible recipients. The Centers for Medicare and Medicaid should decide whether to send reminders to all recipients at ages 50, 60, and 70, or to send reminders to all recipients ten years after their previous colonoscopy, based on the availability of screening data. All new Medicaid enrollees over the age of 50 should also be mailed reminders. The reminders should be mailed out by Department of Health and Human Services administrative assistants, or some equivalent, based on the eligibility and addresses of recipients as presented in the established database. Once more, if labor costs can be cut without sacrificing the accuracy of the mailing process (through the use of volunteers or interns) it would be ebenficial to the program overall.

It will be important for CMS to assess the success of the program. In order to do this, CMS can choose to include a completion survey with the reminder, and request that recipients mail the survey back to CMS if they received some form of colorectal screening after receiving the reminder. While this information would be valuable to the program, it is likely that many recipients will not return the survey, and that number of surveys returned will not be representative

of the number of recipients that receive screenings. CMS might find it more effective to collect completion information at the statewide level by comparing state Medicaid receipts before and after the implementation of this intervention. This approach does not account for external trends, however, and does not necessarily establish a causal relationship between the reminders and overall trends in screening. Since both of these strategies have serious flaws, this analysis encourages CMS to come up with other strategies for assessment if possible.

Uncertainties about the Upcoming Administration

The election of Donald Trump to the Office of President, and the election of Republican majorities to both the House of Representatives and the Senate, leads this analysis to expect that significant changes await healthcare in the United States. This analysis is unsure of how significantly these events will impact the possibility of implementing Option 1. Given that this administration is anticipated to focus on cutting costs, it may be hesitant to fund Option 1, since it has sizable upfront costs and high costs overall. If this is the case, it should be noted that, under the primary cost-effectiveness analysis conducted by this analysis, Option 2 is not significantly less cost-effective than Option 1. Unlike Option 1, Option 2 might be palatable to the new administration since it has no start-up costs, and a flexible funding model that does not sacrifice cost-effectiveness when adjusted to scale. CMS should prepare to execute Option 1, but should keep Option 2 in mind if Option 1 is met with great resistance from the administration or from significant systemic changes.

Appendix

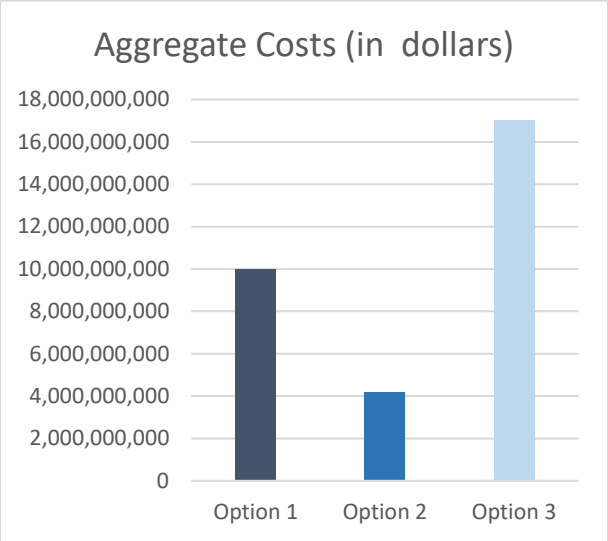
Appendix 1

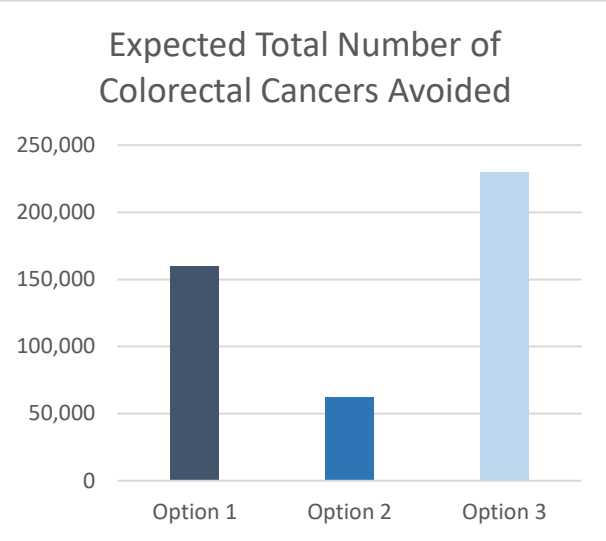
	NEW CASES				DEATHS			
	MALE		FEMALE		MALE		FEMALE	
AGE, YEARS	Count	%	Count	%	Count	%	Count	%
Birth to 49	7,550	11	6,650	10	2,000	7	1,490	6
50-64	24,410	34	18,030	28	7,600	28	4,840	21
65-79	26,950	38	22,230	35	10,120	37	7,480	32
≥80	12,510	18	17,100	27	7,430	27	9,300	40
All ages	**71,420**	**100**	**64,010**	**100**	**27,150**	**100**	**23,110**	**100**

a Estimates are rounded to the nearest 10.

Taken from Siegel et al, 2017[8]

Appendix 2





Appendix 3: Technical Appendix

General Assumptions

- Discount Rate (3%)
    - Standard discount rate for government programs recommended by the Office of Management and Budget. Relevant when effectiveness outcomes are delayed from affiliated costs. All discounting is done using the equation Present Value = Future Value / (1 + Discount Rate)^Time in Years, calculated at year's end.
- Percent Medicaid Population up-to-date on Screenings (50%)
    - Based on data from New York[53] and Minnesota.[54] These two states were chosen because screening colonoscopy is fully covered in these states, making 50% a conservative estimate for the number of Medicaid recipients unscreened. The purpose of this assumption is to assert that there is room for improvement in preventive screening frequency in the Medicaid population. With 50% of Medicaid recipients unscreened, it is can be assumed that all additional screenings from the interventions are worthwhile.
- Effectiveness of Colonoscopies in finding and removing all polyps (70%)

  - From a meta-analysis by Brenner et al in 2014,[55] which found that colonoscopy reduces the incidence of colorectal cancer by 69% on average. This value was rounded to 70% for simplicity.
- If colonoscopy removes all polyps, patients are risk free for 10 years
  - Based on CDC's recommendation[56] that individuals between the age of 50 and 75 should receive a colonoscopy every 10 years to optimally prevent colorectal cancer. While it is likely that 10 year colonoscopy does not completely remove the risk of colorectal cancer, it is unclear how many cases of cancer develop despite effective colonoscopy. For ease of calculation, it is assumed that a colonoscopy that removes all polyps eliminates risk of colorectal cancer for 10 years.
- Market Price of Colonoscopy ($2000)
  - Price of colonoscopy varies greatly by region, with averages spanning $1000[57] to $3000+.[58] $2000 was chosen as an intermediate value for the purpose of calculations for these national interventions.
- Lifetime Risk of Incidence of Colorectal Cancer at age 50 (5%)
  - Taken from the SEER Cancer Data Archive.[59]
- All cancer cases that existed before first colonoscopy in this 10 year period would have been found regardless of these interventions
  - This analysis is concerned with the number of cases of colorectal cancer prevented by these interventions. Calculating if existing cases of cancer are found earlier, and measuring affiliated costs and effects, is beyond the scope of this analysis.
- All removed polyps that would have become cancer would have done so within the year
  - While it can take up to 10 to 15 for a polyp to become cancer, it is impossible to know how long a polyp has been present when it is removed. For the purpose of simplicity in this analysis, it will be assumed that all polyps removed would have become cancer within the next year.
- Risks and complications of colonoscopy are too infrequent and generally minor to act as significant costs
  - The risks associated with colonoscopy are generally minor, with the exception of perforation. Perforation, however, occurs at such a low frequency that it was not considered a significant cost in this analysis.[60]

Assumptions for Option 1

- Number of individuals enrolled in Medicaid (74,493,736)
    - Taken from Medicaid.gov.[61] The number used represents the enrollment in March 2017, which is assumed to be a consistent value for the 10 year intervention. (Thus it is assumed that new enrollees balance enrollees removed from the system)
- Percent of Medicaid Enrollees above the age of 50 (21%)
    - Taken from the Kaiser Family Foundation.[62] This age is distribution is assumed to be consistent over the 10 year intervention.
- Medicaid recipients over 50 are evenly distributed across ages 50 and 75
    - While it is unlikely that Medicaid recipients are evenly distributed across these ages, it is almost impossible to find more specific, publicly accessible data on age distribution in the Medicaid population. Assuming even distribution allows for calculation of people turning 50, 60, and 70, who are recommended to receive colonoscopies.
- Medicaid Enrollees due for a colonoscopy in a given year (5%)
    - If it is assumed that Medicaid recipients are evenly distributed throughout the age bracket of 50 and 75, and we know that 21% of Medicaid recipients are above the age of 50, we can calculate that approximately 3% of Medicaid recipients are turning 50, 60, or 70, and are due for a 10-year colonoscopy. It is assumed that not everyone will get a colonoscopy at these scheduled dates, and so the assumption is bumped up from 3% to 5% in a given year, to roughly account for people who should have but did not get colonoscopies in their 50^{th}, 60^{th}, or 70^{th} years.
- Number of new Medicaid Enrollees per year (18,173,405)
    - Taken from Medicaid enrollment data from 2016. It is assumed that all years in the ten year intervention period will resemble 2016.[63]
- Number of new Medicaid Enrollees age 50 and above per year (3,816,405)
    - Based on the data from the previous assumption, and the assumption that incoming Medicaid recipients will demographically resemble current Medicaid recipients (which are 21% over 50.) Calculation: 18,173,405 * .21 = 3,816,405
- Cost to Develop Reminder Content ($1000)

  - An assumption by the analyst.
- Cost of Creating a Registry Database to track Recipients due for Colonoscopy ($67,000,000)
  - Taken from an IT dashboard analysis of costs for an FDA database of similar scope and function.[64]
- Cost of Yearly Maintenance of Database
  - Includes the cost entering and removing new and old recipients. Taken from an OMB analysis of an FDA database of similar scope.[65]
- Cost of Materials and Postage for one letter ($2.00)
  - Author assumption, loosely based off of a cost effectiveness analysis by Lich et al in 2017.[66] While the Lich analysis only looked at paper, ink, and postage for a simple letter (estimated to be $0.70 per letter), this letter will contain an informational brochure, which is expected to be slightly more expensive.
- Administrative Assistant Hourly Salary ($15.00)
  - Taken from payscale.com.[67]
- Number of Reminders and Mailed Prepared in One Hour (15)
  - Author Assumption of 4 minutes per reminder.
- Time (Hours) Required to Prepare and Mail Reminders (403,415)
  - Number of reminders needed per year (Medicaid Enrollees due for a colonoscopy in a given year + New Medicaid Enrollees over the age of 50) divided by the number of reminders prepared and mailed per hour.
  - Calculation: ((74,493,736*.3)+3,816,405)/15= 403,415
- Percent of Reminders expected to reach their recipient through USPS (75%)
  - Lich et al[68] assumes that 90% of letters mailed by USPS reach their destination. Given the general transience of low-income populations, and the difficulty associated with keeping track of people, this analysis assumes only 75% of mailed reminders will reach their destination through USPS.
- Increased likelihood of receiving screening after receiving reminder (10%).
  - A controlled study by Lewis et al in 2008[69] found mailed reminders increased colorectal screening likelihood by 11%.[70] A study by Lee et al in 2011 found an increase of 8%. 10% was chosen as a simple, intermediate value.

Cost Calculations for Option 1

- Develop Reminder Content
    - The cost of developing the reminder to be sent out. Cost value from assumptions as a one-time cost in year 1.
- Creation of Registry Database to track Recipients due for Colonoscopy
    - The cost of creating a database to track reminder recipients. Cost value taken from assumptions as a one-time cost in year 1.
- Yearly Database Maintenance
    - Cost of keeping database up-to-date. Cost value taken from assumptions as a yearly cost all ten years, discounted yearly at a rate of 3%.
- Staff time to prepare and mail reminders
    - Cost of staff wages, calculated by multiplying assumed wage rate by the number of hours required to prepare and mail all reminders in a given year. Calculation: 15*502,740= 7,541,101. Taken as a yearly cost for all ten years, and discounted yearly at 3%.
- Materials and Postage
    - Cost of physical reminders. Calculated by multiplying the sum of the number of Medicaid recipients times the number of recipients due for a colonoscopy each year, plus new yearly Medicaid enrollees over 50, by the cost of each physical reminder. Calculation: (74,493,736*.05+3,816,415)*2= $15,082,203. Taken as a yearly cost for all ten years, and discounted yearly at 3%.
- Additional Colonoscopies
    - Market price of colonoscopies (from assumptions) multiplied by expected increase in colonoscopy per year. Calculation: 2000* 565,582 = $1,131,165,277. Taken as a yearly cost and discounted at 3%.
- Total Cost
    - The sum of all previously mentioned costs, across all ten years of the intervention. Aggregate Social Cost = 10,204,752,468

Effectiveness Calculations for Option 1

- Additional Colonoscopies per Year
    - The number of people receiving reminders (number of enrollees requiring colonoscopy in a given year + new enrollees over 50), times the effectiveness of a reminder at increasing likelihood of screening, times the percentage of letters that reach their destination through USPS. Calculation: (74,493,736*.05+3,816,415)*.10*.75 = 565,582. Taken as a yearly value, and discounted at 3%.
- Expected Total Increase in Colonoscopy
    - The sum of Additional Colonoscopies per Year from each of the 10 years. Aggregate Increase in colonoscopy: 4,969,270
- Cases of Colorectal Cancer Avoided per Year
    - Additional Colonoscopies per Year times the effectiveness of colonoscopy at removing all polyps times the lifetime risk of colorectal cancer at age 50. Calculation: 565,582*.70*.047= 18,607. This is value discounted at 3% per year.
- Total Cases of Colorectal Cancer Avoided
    - The sum of Cases of Colorectal Cancer Avoided per Year from each of the 10 years. Aggregate Cases Avoided: 163,489

Cost-Effectiveness Calculations for Option 1

- Cost per Additional Screening
    - Total Cost divided by Total Increase in Colonoscopy. Calculation: 10,204,752,468/4,969,270 = $2053
- Cost per Case of Colorectal Cancer Avoided
    - Total Cost divided by Total Cases of Colorectal Cancer Avoided. Calculation: 10,204,752,468/163,489 = 62,418

Assumptions for Option 2

- CMS Budget for Colorectal Cancer Interventions ($5,000,000)
    - Author assumption. Does not affect the cost-effectiveness of this option, but does affect total overall costs and number of colonoscopies, as well as the potential scope of the program.

- Cost of Hospital Salaries to Administer Patient Navigation System ($150,000)
    - Loosely based on findings from controlled, observational analysis by Elkin et al from 2012.[71] The salaries range from 100,000 to 300,000 depending on the paygrade of the people running the system. $150,000 assumes nurses and hospital secretaries are working the system.
- Number of Additional Colonoscopies per hospital from Patient Navigation (650)
    - Also taken from the Elkin et al[72] analysis. The study found between 528 and 804 additional colonoscopies per hospital per year. 650 was chosen as an intermediate value.
- Effectiveness of Colonoscopies in finding and removing all polyps under option 2 (70%)
    - Lebwohl et al idenitified in 2011[73] that patient navigation led to a significant increase in colonoscopy preparation quality in Medicaid patients. Though it is well-established that increased colonoscopy preparation quality increases the accuracy of colonoscopy in identifying polyps, the Lebwohl study did not make clear how much this increase in preparation quality increased the accuracy of the colonoscopy. Other literature on patient navigation effects on colorectal screening altogether does not mention increased preparation quality for colonoscopy. For the base analysis of this study, colonoscopy accuracy under option 2 will be treated as the same as option 1, but this factor will be manipulated during sensitivity analysis.

Cost Calculations for Option 2

- Yearly Budgetary Costs ($50,000,000)
    - CMS Budget for colorectal cancer interventions taken as a yearly cost, discounted at 3% per year.
- Additional Colonoscopies
    - Market Price of Colonoscopies multiplied by expected increase in colonoscopy. Calculation: 2000*216,666 = 433,333,333. Taken as a yearly cost, discounted at 3% per year.
- Total Cost:
    - Sum of all other cost categories across all 10 years of the intervention. Aggregate Social Cost: $4,246,619,312

Effectiveness Calculations for Option 2

- Additional Colonoscopies per Hospital
    - Value taken from assumptions. Treated as a yearly value, discounted at 3% per year.
- Staff Salaries per hospital
    - Taken from assumptions. Used to calculate the number of hospitals funded given the CMS budget.
- Number of Hospitals Funded
    - Yearly budgetary value divided by cost of salaries per hospital. Calculation: 50,000,000/150,000 = 333
- Additional Colonoscopies per Year
    - Number of hospitals funded multiplied by additional colonoscopies per hospital per year. Calculation: 333*650= 216,666. Taken as a yearly value, and discounted at 3% per year.
- Expected Total Increase in Colonoscopy
    - The sum of Colonoscopies per Year from all ten years of the intervention. Aggregate increase in colonoscopies: 1,903,656
- Cases of Colorectal Cancer Avoided per Year
    - Additional Colonoscopies per Year times the effectiveness of colonoscopy at removing all polyps under option 2 times the lifetime risk of colorectal cancer at age 50. Calculation: 1,903,656*.70*.047= 712. This is value discounted at 3% per year.
- Total Cases of Colorectal Cancer Avoided
    - The sum of Cases of Colorectal Cancer Avoided per Year from each of the ten years. Aggregate Cases Avoided: 62,630

Cost-Effectiveness Calculations of Option 2

- Cost per Additional Screening
    - Total Cost divided by Total Increase in Colonoscopy. Calculation: $4,246,619,310/1,903,656= $2,230
- Cost per Case of Colorectal Cancer Avoided

- Total Cost divided by Total Cases of Colorectal Cancer Avoided. Calculation: $4,246,619,310/62,630 = $67,804

Assumptions for Option 3

- Cost of a GI Visit ($420)
  - The national, average market price for a new patient visit to a gastroenterologist.[74]
- Current Medicaid Physician Reimbursement Rate (60%)
  - Medicaid reimbursement rates vary by service type and by state, but on average the Medicaid program pays physicians 60% of what they would be paid by a private insurance provider for the same service.[75]
- Increased in Number of Patients Accepted because of Heightened Reimbursement (5%)
  - According to an analysis of the Medicaid fee bump by Polski et al in 2015,[76] increased reimbursement rates seem to incentivize Medicaid doctors to increase their patient pool by approximately 5%.
- New GI Patients will all be eligible for a colonoscopy, and will receive one after first visit
  - This study assumes that all new patients accepted because of the reimbursement increase will be eligible for a colonoscopy, and interested in pursuing one after their first meeting.
- Number of individuals enrolled in Medicaid (74,493,736)
  - Taken from Medicaid.gov.[77] The number used represents the enrollment in March 2017, which is assumed to be a consistent value for the 10 year intervention. (Thus it is assumed that new enrollees balance enrollees removed from the system)
- Percent of Medicaid Enrollees above the age of 50 (21%)
  - Taken from the Kaiser Family Foundation.[78] This age is distribution is assumed to be consistent over the 10 year intervention.

Cost Calculations for Option 3

- Additional GI Visits
  - Calculated by multiplying the number of Medicaid recipients over the age of 50 by the percentage expected increase in patients accepted because of the reimbursement increase, multiplied by the market price of a GI visit. Calculation:

74,493,736*.21*.05*420= $328,517,375. Taken as a yearly cost, and annually discounted at 3%.

- Additional Colonoscopies
    - Calculated by multiplying the expected additional colonoscopies per year by the market price of colonoscopy. Calculated 782,148*2000 = $1,564,368,456. Taken as a yearly cost, and annually discounted at 3%.
- Total Cost
    - Sum of all other cost categories across all 10 years of the intervention. Aggregate Social Cost: $16,631,101,094

Effectiveness Calculations for Option 3

- Additional Colonoscopies per Year
    - Calculated by multiplying the number of Medicaid recipients over the age of 50 by the percentage expected increase in patients accepted because of the reimbursement increase, given the assumption that all new patients should and will receive colonoscopies. Calculated: 74,493,736*.21*.05 = 782,184. Taken as a yearly value, and discounted annually at 3%.
- Expected Total Increase in Colonoscopy
    - The sum of Colonoscopies per Year from all ten years of the intervention. Aggregate increase in colonoscopies: 6,872,355
- Cases of Colorectal Cancer Avoided per Year
    - Additional Colonoscopies per Year times the effectiveness of colonoscopy at deterring colorectal cancer times the lifetime risk of colorectal cancer at age 50. Calculation: 782,184*.70*.047= 25,733. This is value discounted at 3% per year.
- Total Cases of Colorectal Cancer Avoided
    - The sum of Cases of Colorectal Cancer Avoided per Year from each of the ten years. Aggregate Cases Avoided: 226,100

Cost-Effectiveness Calculations for Option 3

- Cost per Additional Screening
    - Total Cost divided by Total Increase in Colonoscopy. Calculation: $16,631,101,094/6,872,355= $2,420
- Cost per Case of Colorectal Cancer Avoided
    - Total Cost divided by Total Cases of Colorectal Cancer Avoided. Calculation: $16,631,101,094/226,100= 73,556

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