



HONORS PROGRAM

Charles Buhrman

Colorectal Cancer Screenings in the United States

Mathematics

27 April 2017

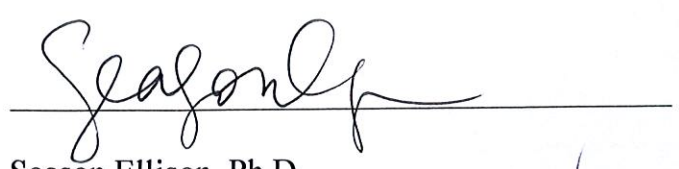
Bemidji State University
Honors Program
Department of Mathematics

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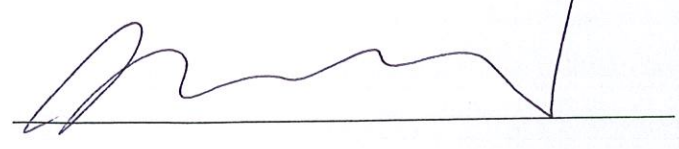
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Abstract:

Colorectal cancer is the second leading cancer killer in the United States behind lung cancer, so research is needed about this particular cancer (American Cancer Society, 2016). With medical advancements over the past decade, doctors are able to detect cancer symptoms earlier and treat cancers more readily. By compiling the medical record data for the Midwest and the Northeast, a picture can be painted that shows the prevalence of screenings in each region, and the mortality rates of those regions based on the amount of screenings done. The aim of this study is to examine the current colorectal cancer (CRC) screening processes and treatments between the Midwest and New England regions. This thesis establishes statistical lineage between these two regions in an attempt to analyze the success rate of standard procedures used to deal with colorectal cancer. After considerable data analysis, it can be noted that states with better CRC screening rates showed cancer incidence rates 5% to 20% lower than the national average, and mortality rates 6% to 15% lower than the national average for colon cancer. Further research is needed to determine whether these lower averages are directly caused by higher screening rates or if this is just simply a statistical parallel.

Annotated Bibliography

Bird, Joyce Adair, et al. "Three Strategies to Promote Cancer Screening: How Feasible Is Wide-Scale Implementation?" *Medical Care* 28.11 (1990): 1005-12. Print.

Doctors Joyce Bird, Stephan McPhee, Christopher Jenkins, and Don Fordham worked together to get this article published in a well-recognized medical journal. This article highlights the pros of cancer screening and how nationwide implementation of cancer screening programs can be put into effect. Their findings relate to my study because, not only do they discuss the benefits of cancer screening, but they also discuss the political and economic realities of early diagnosis. I can use their findings to relate back to my regional synthesis of New England and the Midwest to see what each region does similarly or differently to promote CRC screenings.

"Colorectal Cancer: Facts and Figures." American Cancer Society, 2017. Web. 7 Apr. 2017.

This comprehensive study touches upon all the basic introductory knowledge about colorectal cancer. This publication, from the American Cancer Society, discusses the symptoms, the stages, the risks (age, sex, race, demographics), and the treatments involved with colon cancer. The study includes graphs and figures that show the geographical variations in colorectal incidence and mortality in the United States. I can use this study to solidify my background knowledge of colon cancer and to familiarize myself with variables I need to consider when creating this meta-analysis.

Robertson, Douglas J. "Colorectal Cancer on the Decline – Why Screening Can't Explain It All."

New England Journal of Medicine, 28 Apr. 2016. Web. 7 Apr. 2017.

This article explains the decline in colorectal cancer mortality in the United States over the past 30 years. This source touches on alternate reasons for why CRC mortality rates are dropping other than an increase in preventative screenings. This article mentions everything from changes in diet to the use of antibiotics as possible factors. This source is full of statistical evidence for these claims and is published in a credible source, the New England Journal of Medicine. I can use this source to defend my argument that screenings aren't directly to blame for a decline in colorectal cancer diagnosis'.

Sabatino, Susan A., and Mary C. White. "Cancer Screening Test Use." *Morbidity and Mortality Weekly Report* 64.17 (2015): 464-68. Print.

This article argues for the support of cancer screening using statistical evidence provided in the weekly *Morbidity and Mortality Report*. The authors write clear and strong, and are in favor of cancer screening in the U.S. This article directly contradicts the ideas of Dr. Welch and provides more beneficial evidence for why CRC screenings are necessary.

Welch, H. Gilbert. *Over-diagnosed: Making People Sick in the Pursuit of Health*. Boston: Beacon, 2011. Print.

Dr. Welch argues that preemptive treatment and early diagnosis is economically bad for Americans and is only beneficial to the medical field. This is the idea that sparked my interest in questioning this topic for my honors thesis. Dr. Welch developed the idea of 'overdiagnosis', which is essentially what I am trying to test the validity of throughout my entire project. He

argues, from his own personal experience of being a doctor, that there is reason to doubt the treatments and preventative options being presented to us by our doctors. Dr. Welch provides many personal stories and medical facts to establish this idea that they may be a profit motive for the medical field to push unnecessary practices on us.

Introduction:

The topic of cancer screenings and diagnosis is an interesting discussion point today. Medical advancements since the 1970s have allowed for doctors to make preemptive decisions and see cancers long before they become life threatening. Colorectal cancer, in particular, has seen a reduction in incidences because of more thorough screenings. (Sabatino, 2015)

According to the New England Journal of Medicine, colorectal cancer numbers have had a favorable trend since this outbreak of new technology. They illustrate this when they say, “The big picture is unambiguous ‘good news’: overall colorectal cancer incidence has dropped by almost 40% since 1975 and by more than 45% since its peak in the mid-1980s. More important, colorectal cancer mortality has fallen by more than half” (Robertson, 2016). Colorectal cancer screening rates and colorectal cancer incidence rates vary in different regions of the U.S., thus regional CRC mortality rates are apparently influenced by screening rates, but other factors also influence this difference.

This drop in colorectal cancer mortality nationwide cannot be completely attributed to screenings alone. For one, available treatments are better than they were 30 years ago. Preoperative and postoperative care has been standardized. Additionally, people with colorectal cancer symptoms are being diagnosed earlier, which is due in part to screening procedures, but it also has to do with the difference between preventative and diagnostic screening methods. Doctors can more readily diagnose patients with symptoms of colon cancer because of their expertise in preventative screening and the readily available technology. (Welch, 2011) In other words, with better cancer finding technology; doctors are quicker to diagnose colon cancer when symptoms present themselves. A final reason that colorectal cancer mortality has decreased is because there are fewer people with colon cancer. This decrease in CRC cases is due to many

factors, such as dietary changes, lower rates of smoking, and healthier lifestyles. (Robertson, 2016).

The purpose of this study is to find out how an individual regions' screening procedures effect colon cancer mortality rates. We know, as a whole, colon cancer mortality rates are declining and have been since the mid-1980s, which was the peak era for colorectal cancer incidence. The greater purpose of this research is to examine if states with higher rates of screening do in fact have lower mortality rates. Theoretically, if the preemptive screening method works, states that have more screenings would have fewer deaths. Even though, there are many more factors (other than screenings) that could affect a region's colon cancer death rate, there should still be some statistical correlation between screening numbers and mortality.

When it comes to screening options, there are several recommended methods including visual exams and stool based tests. The American Cancer Society says, "All tests have a comparable ability to reduce CRC death when performed at the appropriate time intervals and with the recommended follow-up. Positive results from any tests other than colonoscopy should be followed with a colonoscopy for complete diagnostic evaluation. Patients should be given information about the benefits and limitations of each screening test, and choose one based on their health, medical history, and preferences" (CRC: Facts and Figures, 2017, p.15). The typical visual exam people think of when it comes to colon cancer is the colonoscopy, but other kinds of exams include: a computed tomographic colonography (CTC), a double-contrast barium enema, or a flexible sigmoidoscopy.

A colonoscopy is the most common screening test for CRC in the United States. Usually performed by a gastroenterologist, a colonoscopy allows for a direct visual scope of the rectum and colon. A probe, called a colonoscope, is used to view the intestinal lining via the rectum and

colon. The colonoscope has a light and camera on the end to allow for detection and removal of any polyps found during the procedure. A polyp is a clump of cells that forms on the lining of the colon or the rectum. Most polyps are harmless but over time they can develop into colon cancer. It's common to develop polyps in your colon, but people who are over 50 years old, are overweight, smoke, or who have a history of colon cancer are at higher risks for the polyps developing into colon cancer (CRC Statistics, 2016).

Some examples of stool based tests are: fecal immune-chemical test (FIT), high-sensitivity guaiac-based fecal occult blood test (gFOBT), and FIT-DNA test (Cologuard). Positive stool tests should be further examined through a colonoscopy. The American Cancer Society supports this procedural plan when they say:

Cancerous tumors and some large polyps bleed intermittently into the intestine. This blood, which may not be visible, can be detected in stool with special tests. Modeling studies suggest that annual screening with high-sensitivity stool tests will result in a reduction in CRC mortality comparable to that achieved by colonoscopy over a lifetime of screening...Patients with a positive stool test are further evaluated with a diagnostic colonoscopy. (CRC: Facts and Figures, 2017, p. 18)

Colorectal cancer is the most common cancer screened for, and it is one of the easiest to detect as well. With all of these screening methods available, it's no surprise that nationwide CRC screening rates are rising while mortality rates are falling (Bird, 1990). Along with multiple screening options, those diagnosed with colon cancer have several treatments to consider as well.

Treatments for colorectal cancer include: surgery, chemotherapy, biological therapy, and radiation therapy. According to the U.S. Oncology Network, surgery is the most common treatment. The three types of surgery are via: colonoscopy, laparoscopy, and open surgery.

Chemotherapy simply uses anti-cancer drugs to kill cancer cells. Some side-effects from chemo include: fatigue, hair loss, nausea and vomiting, diarrhea, loss of appetite, mouth sores, and cold intolerance. Biological therapy is a newer area of drug development that studies the molecular changes involved in cancer occurrences. These drugs have less severe side effects than conventional chemo drugs. Some people receive both chemotherapy and biological therapy at the same time. Radiation therapy, also called radiotherapy, uses high energy rays to kill cancer cells. Side effects of radiation therapy can include: skin irritation, nausea, diarrhea, inflammation, fatigue, and bladder irritation (Colon and Rectal Treatment Options, 2017). None of these treatment options are ideal, but there is hope for recovery with them all.

Summary of Findings:

New England:

For my study of the incidence and mortality of CRC in the New England area, the three main states I chose to examine were Massachusetts, New Hampshire, and Vermont. All three of these states show very low incidence rates of CRC relative to the 2016 national average of 40.6 cases per 100,000 people per year. Massachusetts had an incidence rate of 36.4 cases per 100,000 according to the National Cancer Institute in 2016, and an incidence rate of 38.9 cases according to the Centers for Disease Control and Prevention in 2013. Consequently, New Hampshire had an incidence rate of 37.0 cases in 2016 and 37.9 cases in 2013, and Vermont had an incidence rate of 31.7 cases in 2016 and 37.4 cases in 2013 (See Figure 1 and Table 1).

As you can see, the CRC incidence rates drop in each state from the 2013 CDC survey to the 2016 National Cancer Institute findings. Vermont does seem to show very low incidence rates in 2016, but this could be attributed to rounding errors in the translation of data from state to state, discrepancies in the VT medical books, or even poor sampling data for that given year.

What is consistent is the fact that incidence rates have dropped over this three-year span. This drop can be attributed many different factors such as better health care and healthier lifestyle choices. Along with computing incidence rates for CRC, the Centers for Disease Control and Prevention and the National Cancer Institute also conducted mortality rates due to CRC for the same given years. They calculated a national CRC mortality rate average of 15.1 deaths per 100,000 people per year in 2016. Massachusetts had a CRC mortality rate of 12.9 deaths per 100,000 people in 2016 according to the National Cancer Institute and a rate of 13.8 deaths in 2013 according to the CDC. Consequently, New Hampshire had a mortality rate of 13.0 deaths in 2016 and 13.7 deaths in 2013, and Vermont had a mortality rate of 14.2 deaths in 2016 and 14.3 deaths in 2013 (See Figure 2 and Table 2). Once again, the mortality rates show a slight decrease over this three-year span, which makes sense considering incidence rates are declining as well (State Cancer Profiles, 2017) (CRC Rates by State, 2016).

Midwest:

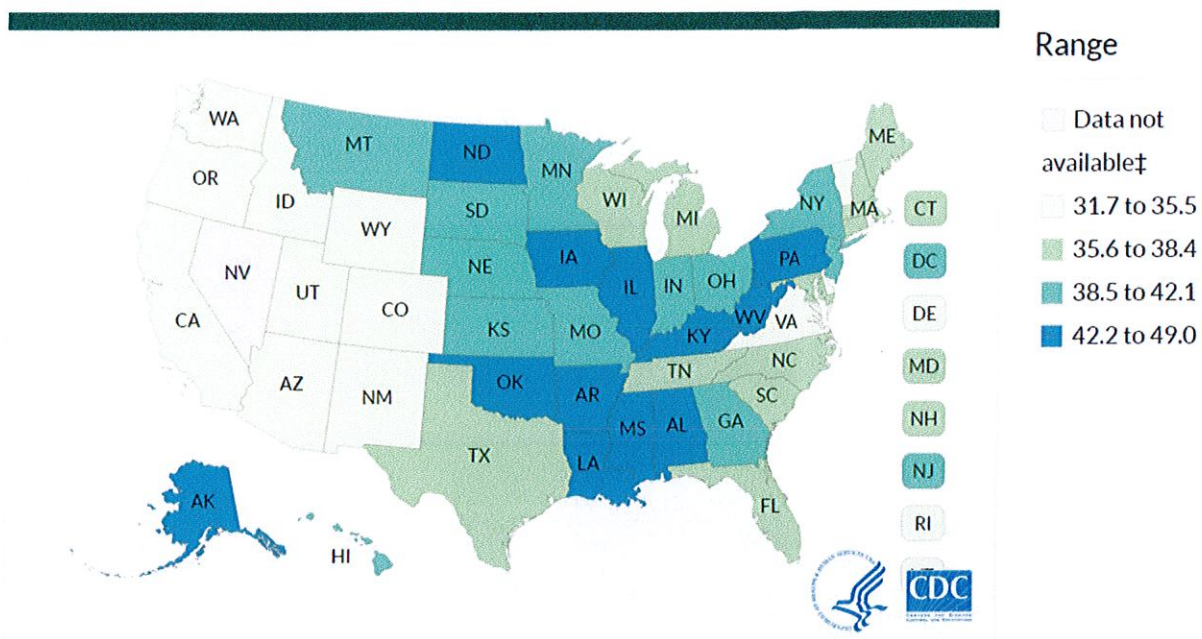
For my Midwest study, I chose to examine North Dakota, South Dakota, and Iowa. I decided to omit Minnesota from this comparison because the numbers were so close to that of the New England states, that I didn't want to skew the results for the rest of the Midwest. Minnesota is among one of the healthiest states in the U.S.; in terms of obesity rates, medical coverage, and cancer rates, so trying to compare MN to the high medical standards of the Northeast is not representative of the Midwest, as a whole. In my findings, the Midwestern states performed at a much lower quality than New England in terms of screening and CRC numbers. Leaving Minnesota out of the Midwest regional data, allows for this difference between the Midwest and New England to be examined more closely.

According to the National Cancer Institute, the national average of CRC incidence is 40.6 cases per 100,000 people per year. North Dakota came in at 46.0 cases per 100,000 people in 2016 according to the National Cancer Institute and 47.1 cases in 2013 according to the CDC. Consequently, South Dakota had 40.8 cases in 2016 and 45.2 cases in 2013, and Iowa had 42.9 cases in 2016 and 45.5 cases in 2013 (See Figure 1 and Table 1). As you can see, all three of these midwestern states are well above the national average for incidence rates.

Likewise, in reviewing mortality rates for these Midwest states, the data reflects the above stated incidence rates. Noting that the national CRC mortality rate in 2016 was 15.1 deaths per 100,000 people, North Dakota had 15.7 deaths in 2016 according to the National Cancer Institute and 15.6 deaths in 2013 according to the CDC. Consequently, South Dakota had 15.7 deaths in 2016 and 16.6 deaths in 2013, and Iowa had 15.5 deaths in 2016 and 16.4 deaths in 2013 (See Figure 2 and Table 2). These states showed a decline in mortality rates from 2013 to 2016, except for North Dakota who actually showed a miniscule increase in CRC mortality (State Cancer Profiles, 2017) (CRC Rates by State, 2016).

Figure 1:

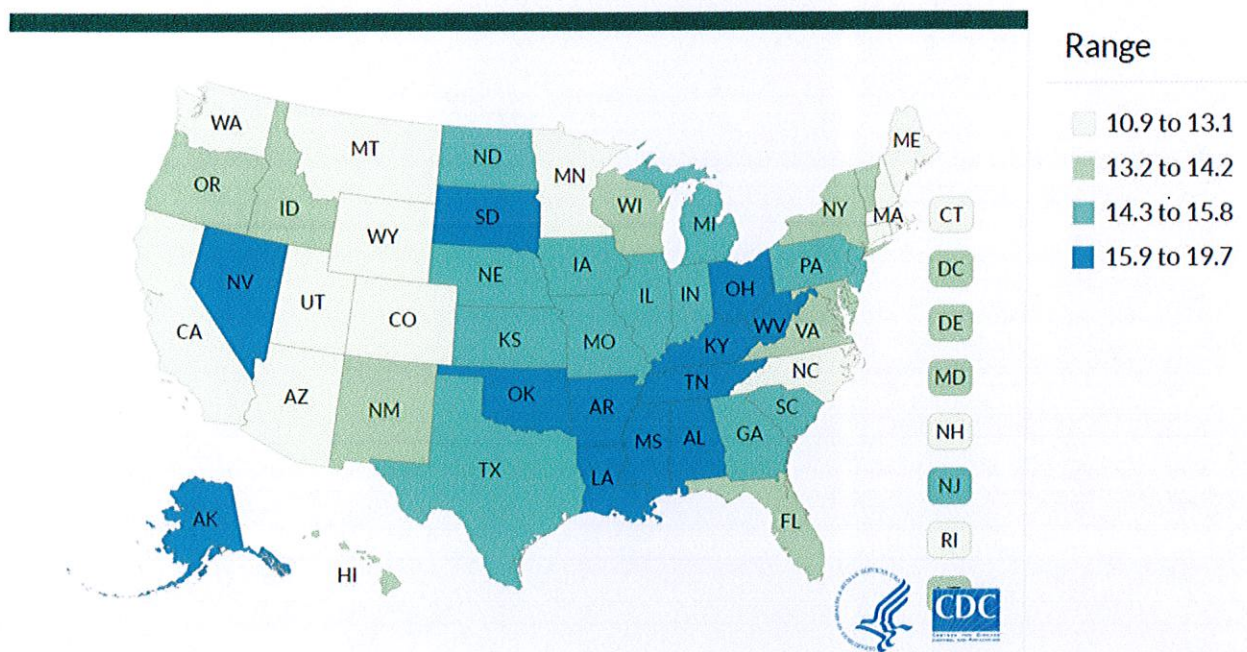
**Colorectal Cancer
Incidence Rates* by State, 2013†**



(CRC Rates by State, 2016)

Figure 2:

**Colorectal Cancer
Death Rates* by State, 2013†**



(CRC Rates by State, 2016)

Table 1:

	Incidence Rate per 100,000 2013	Incidence Rate per 100,000 2016	Percent Change	National Incidence Rate 2016	Variation from National Average	Screening Rates (Adults 50+)
Massachusetts	38.9	36.4	(6.43%)	40.6	(10.34%)	76%
New Hampshire	37.9	37.0	(2.37%)	40.6	(8.87%)	74%
Vermont	37.4	31.7	(15.24%)	40.6	(21.92%)	71%
North Dakota	47.1	46.0	(2.34%)	40.6	13.30%	64%
South Dakota	45.2	40.8	(9.73%)	40.6	0.49%	67%
Iowa	45.5	42.9	(5.71%)	40.6	5.67%	68%
Minnesota	39.6	38.7	(2.27%)	40.6	(4.68%)	72%

(CRC: Facts and Figures, 2017, p. 17) (State Cancer Profiles, 2017) (CRC Rates by State, 2016)

Table 2:

	Mortality Rate per 100,000 2013	Mortality Rate per 100,000 2016	Percent Change	National Mortality Rate 2016	Variation from National Average	Screening Rates (Adults 50+)
Massachusetts	13.8	12.9	(6.52%)	15.1	(14.57%)	76%
New Hampshire	13.7	13.0	(5.11%)	15.1	(13.91%)	74%
Vermont	14.3	14.2	(0.70%)	15.1	(5.96%)	71%
North Dakota	15.6	15.7	0.64%	15.1	3.97%	64%
South Dakota	16.6	15.7	(5.42%)	15.1	3.97%	67%
Iowa	16.4	15.5	(5.49%)	15.1	2.65%	68%
Minnesota	13.5	12.8	(5.19%)	15.1	(15.23%)	72%

(CRC: Facts and Figures, 2017, p. 17) (State Cancer Profiles, 2017) (CRC Rates by State, 2016)

Conclusion:

The final step in analyzing these results and making determinations as to how effective the colorectal cancer screening process is for each state, is to look at recent national screening data. If the screening process is truly effective in finding cancer and saving lives, we would expect the amount of screenings to be much higher in New England and Minnesota compared to the other Midwest states that have higher counts of CRC incidence and mortality. This is a simple analysis and doesn't account for several other variables, (such as; technology advancements, better nutrition, healthier lifestyles), but the basis for this research is that there should be a negative correlation between CRC screenings, and CRC incidence/mortality. A negative correlation here would make sense too. The more CRC screenings a state medical system records, the earlier these pre-cancerous cells can be detected and eradicated before becoming full blown colon cancer. Thus, these screenings should result in a direct decrease in patients with CRC.

The American Cancer Society provides geographical data that breaks down the nation's CRC screening process by state and by region. It is standard procedure for an individual without any prior sign or symptoms of CRC to have their first screening at the age of 50, which is what the majority of the screening data published includes. For the three New England states under study, a 2014 American Cancer Society poll showed that 76% of Massachusetts residents 50 years old or older have been screened for colon cancer. Consequently, New Hampshire showed that 74% of their qualified residents have been screened, and Vermont showed that 71% of their residents over 50 were screened (CRC: Facts and Figures, 2017, p. 17). To qualify under this survey, patients had to have had: a fecal occult blood test within the past year, or a sigmoidoscopy within the past five years, or a colonoscopy within the past ten years. The

national average for adults over 50 years old that have been screened for colon cancer was around 68% in 2014, showing that these New England States are well above the national average in terms of CRC preventative screenings given.

For the three Midwest states under study, the American Cancer Society provides data for adults screened over the age of 50. North Dakota had 64% of their population of adults over 50 screened for CRC. Consequently, South Dakota had a 67% screening rate and Iowa had a 68% screening rate. It's also interesting to note that Minnesota had a screening rate of 72% in 2014, which is relatively consistent with New England data (CRC: Facts and Figures, 2017, p. 17). These figures are below or just at the national average for 2014 and thus solidify the theory that screenings lead to lower incidence rates and lower mortality rates. The Centers for Disease Control and Prevention also conducted a study in 2015 that broke down CRC screening percentages for adults over 50 by region, by ethnicity, and by insurance/health care status. When breaking this data down by region, the CDC found that the Northeast had 65.5% of persons over 50 screened for CRC, while the Midwest had 64.0% screened. Although this regional difference isn't as severe as the American Cancer Society poll, the CDC did not omit Minnesota, which likely pulled the Midwest average up.

Another breakdown of CRC screening rates that should be noted is the influence insurance has on the likelihood of getting screened. The CDC showed that of people over 50 years old with health care coverage, 59.6% were screened for CRC. Whereas only 25.1% of people over 50 years old without health care coverage were screened (CRC Statistics, 2016). This is a dramatic difference in screening numbers. Although New England shows lower CRC incidence and mortality rates compared to the Midwest, these disparities in numbers can be attributed to better health care coverage. It seems that people with access to better health care,

such as in states like Massachusetts, New Hampshire, Vermont, and Minnesota, are more apt to screen early and these residents with better coverage are more willing to get screened early. States with lower quality of health care are less likely to have affordable and readily available screenings and treatments for residents showing signs of CRC. It's not clear whether these higher death rates in the Midwest are attributed to fewer screenings or less access to health care overall. Both go hand in hand. What is obvious is that there is a correlation between CRC rates and access to health care. What leads me to believe that health care quality may have a bigger impact on CRC numbers than screenings, is the fact that there is a negative correlation between cancer rates and screenings. You would think that states with higher screening rates would have higher incidence of CRC, but that is not the case. Instead, residents in states with better access to health care endure these screenings, and find and eliminate these polyps before they become cancerous. States with worse health care coverage are more likely to delay the screening process until symptoms are shown, and a lot of times patients are less willing to spend the money to get treatment until their symptoms are advanced. In order to prove this theory conclusively, a controlled experiment would have to be conducted where the only independent variable would be preventative screening. By keeping quality of health care and all other variables constant, we would be able to determine convincingly that preventative screenings are the main factor in the reduction of CRC mortality.

Relating this back to Dr. Welch's work in *Overdiagnosed*, there has been quite the turnaround in terms of the course for this thesis. Dr. Welch's book inspired me to investigate the medical field in depth to see if his theory on preventative screenings and treatments held true with medical data. Welch, a former doctor, argued against the necessity for preventative screenings in certain situations, and he questioned the motives for some hospitals to push the

screening process. Welch reasoned that hospital are profit-motivated industries and that they can only benefit from conducting more screenings and treatment procedures. Welch never explicitly says that preventative screenings do not save lives and lower cancer rates, but he suggests that the benefits gained from preventative cancer screenings may not outweigh the economic and physical costs.

Throughout the thesis process, I've had a realization and a change of opinion from my original biased theory and can confidently say that states with high screening rates for CRC do have lower incidence and mortality rates for CRC cancer. This finding doesn't go directly against the views of Dr. Welch, but this absolutely differs from his findings in *Overdiagnosed*, and the numbers don't lie. There is a definitive statistical correlation between higher CRC rates and lower screening rates, and vice versa. If I were to expand further on this thesis, that's one of the things I would explore more. If I ran a regression analysis or maybe a Students-t distribution to compare both state CRC mortality rates and incidence rates, to state cancer rates. With this basic statistical analysis, I'd be able to find a r-squared value or a p-value to determine if there is actually a true numerical correlation significant enough to notice, which I'm confident there would be for both incidence and mortality rates.

Another area Dr. Welch explored in his book pretty thoroughly was the economic benefits and costs of these screenings. Being an economics minor, I think it would be fascinating to conduct a regional cost benefit analysis for both New England and the Midwest. If I were to do a regional cost benefit analysis, I would need to include more than just three states from each region, but it still would be a fairly basic process. An analysis like this would be more in depth considering hospitals don't always publish their accounting records for the public view, but I think it would be a very interesting future exploration. Even conducting statistical tests using

past vs. present time series data would be a very interesting project, especially if you did an analysis of screening numbers before and after the Affordable Care Act. The possibilities for expanding on this research go every which direction, and the number of statistical relationships that can be found are endless.

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Appendix A:

Charles Buhrman

Honors Thesis Proposal

Colorectal Cancer Screenings in the United States

Advisor: Dr. James White

3 March 2017

Bemidji State University

It is a common and almost obvious assumption that early cancer screenings and other preemptive health practices that the medical field recommends to us are beneficial to our overall health. It may seem like a correct hypothesis to assume that all of these health precautions and testing will directly result in Americans living longer and healthier lives. However, statistics and evidence do not necessarily support this hypothesis. Although life expectancy in the United States has increased steadily over time as technology improves, numerous credible doctors and medical history suggests that quality of life, or healthy life expectancy (the average number of years Americans live free of disease such as; heart disease, cancer, stroke, diabetes) may actually be decreasing from previous generations to the current baby boomer generation (Welch). Is it possible that Americans are living longer yet sicker lives? Are we born into a world where we are living longer, healthier lives, but for some reason we spend more time being told that we're sick? Looking at the statistical results of medical screenings and preemptive practices, we can analyze the cost effectiveness of these treatments. After all, the medical industry is a for-profit business, so it is easy to see why many people may question medical screenings in the United States. The purpose of this research is to compare and contrast literature in support of and against specific preventive screenings frequently recommended in the U.S. Specifically, this research will analyze published data on the cost effectiveness of preventative screenings.

Methods:

This research will compare empirical evidence of colorectal cancer screenings for different regions across the United States. Recent studies that have been conducted, analyzed, and published in a public medical database called Pub Med. This research will gather different studies from across the U.S. Thus, a meta-analysis research published within the last 10 years can be created that compares different regions of the country. A meta-analysis uses a statistical

approach to combine the results from multiple studies in an effort to increase effectiveness, improve estimates of the size of the effect and/or to resolve uncertainty when reports disagree (Biostat).

Specifically, this review will compare and contrast research findings from different regions of the country. The two regions under examination are the Midwest and New England. By including research from two different regions of the U.S., the findings will represent a diverse range of median incomes, demographics, and health care systems. This research may help develop a regional synopsis as to how each region's colorectal screening system is performing, comparatively to the other.

Results: TBD

This research project will examine the value and challenges of preventive colon-rectal cancer screenings.

Summary/Discussion:

The goal of this research project is to compare colorectal screening systems in New England and the Midwest, and to draw conclusions based on the data found. I want to enter this study as impartially as possible and simply view the medical numbers to see if early diagnosis and other preemptive screenings statistically improve life expectancy and quality of life. Although Dr. Welch is the reason why I am questioning this topic in the first place, there is plenty of other evidence positively supporting early diagnosis. *The Morbidity and Mortality Weekly Report*, in regards to cancer screenings, declared with statistical support that, "Regular breast, cervical, and colorectal cancer (CRC) screening with timely and appropriate follow-up and treatment reduces deaths from these cancers" (Sabatino 464). I want to find out if screenings truly reduce deaths from CRC from a statistical/mathematical perspective.

To conduct this study, I will break down my research to the colorectal cancer field for different systems in the Midwest and New England. The first part of my study will be on colon cancer screenings and the success rates of these cancer screenings for all types of people coming from all sorts of different backgrounds within the two regions under examination. Cancer is a major topic for discussion in regards to ‘overdiagnosis’ and CRC will be the focal point of my research. The second part of my research will have to do with the economics behind cancer screenings. Being an economics minor, I can’t complete this study without looking at the cost effectiveness and economic implications of these early diagnoses. I want to discern how much money Americans actually spend on screenings and preemptive procedures and whether or not they are economically making the right decisions. I do not mean to say that seeking treatment if you are ill is economically foolish. Obviously, health and wellness do not have a price tag, but I am simply interested in seeing if screenings that we regularly participate in actually help us in the long run – both physically and economically, or whether, perhaps we engage in unnecessary screenings that become an economic detriment.

When I do complete my thesis research, I hope to have a good collection of statistical resources from each of the two regions I am studying. With a pooled series of medical data based on colorectal cancer, I will be able to draw conclusions as to how soon colon cancer is detected and treated in relation to the two different regions of the country I am studying. I will be able to look at mortality rates, patients in remission, and their survival rate. Then, by using these numbers, I can calculate what the financial costs are for these treatments and procedures on both the medical companies and the patients being treated. I will compare this data to historical medical records and see how much more money the medical field makes since the recent increase in colorectal screenings across the United States. We know testing and treatment on

colorectal cancer has increased dramatically in the past three decades, but I am interested in seeing how beneficial these changes have actually been for sick patients who require treatment.

Literature Review:

This research project will require extensive research and information regarding colorectal screenings, including a wide range of opinions and data sets that both support and refute early diagnosis in the medical field. Dr. H. Gilbert Welch, a Medical Doctor and Professor of Medicine, Community & Family Medicine, The Dartmouth Institute, has authored a book called *Overdiagnosed*. Within this book he argues against early detection and screening for cancer.

However, various peer-reviewed publications support the practice of early screening.

Organizations such as the American Cancer Society highly recommend regular screenings for skin, colorectal, testicular and breast cancer; and they fully believe in the efficiency and benefits these screenings bring. The American Cancer Society recommends that men and women over the age of 50 should participate in one of the following screenings: flexible sigmoidoscopy (every 5 years), colonoscopy (every 10 years), double-contrast barium enema (every 5 years), or CT colonography (every 5 years). (American Cancer Society) This topic is highly debated, and there is statistical evidence to support both sides. Finding the truth within the data to complete this study will require analyzing a broad range of sources, including government supported web-sites like the American Cancer Society and the Center for Disease Control and Prevention.

Because this idea, that preemptive screenings can be harmful to people, is such a bold and declarative statement, I must first cut down the sample size and target a reasonable study. If I were to try to establish whether or not pre-diagnosis is beneficial to patients, I may never come up with a distinct answer. The amount of work and the size of the sample this project would have to assess would be unfathomable. Thus, I will limit this thesis to colorectal cancer in a

comparative study between two different regions of the country. Specifically, this research will look at how screenings have trended over the past 25 years (whether screenings have fluctuated over the past 25 years for each location) and whether or not there is a distinct advantage or disadvantage to regular screenings in these regions. Hopefully by shrinking the sample size and focusing on a target population, the results will show a measurable trend in the data; even if that does mean the focus is on just one specific cancer.

The author that brought about this idea of Americans being excessively searched and screened through medical practices is Dr. H. Gilbert Welch, a former practicing physician who wrote the book titled, *Overdiagnosed*. Welch frequently discusses this idea that people are increasingly being diagnosed with conditions that will never cause symptoms or death, a term he refers to as “Overdiagnosis”. Welch argues that, “Overdiagnosis is a relatively new problem in medicine. In the past, people didn’t go to the doctor when they were well—they tended to wait until they developed symptoms. Furthermore, doctors didn’t encourage the healthy to seek care. The net result was that doctors made fewer diagnoses than they do now” (Welch 9). I am confident that the statistical figures on record will show that, regardless of whether or not early diagnosis actually prevents death and saves lives, doctor visits and profitability in the medical field have increased dramatically as a result of these screenings.

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Appendix B:

Colorectal Cancer Screenings in the United States

Charles Buhrman

27 April 2017

Personal Background Info

- Born and Raised in Plymouth, NH
- Graduated from Plymouth Regional High School (2013)
- Mathematics Major with Actuarial Emphasis
 - Economics Minor
- Dream Job is to work for a successful insurance or financial firm as an actuary
 - Passed the Probability (P-Test) in September

Introduction

- Always been interested in the medical field
 - Personal connections
- *Overdiagnosed*, Dr. Gilbert H. Welch
- Originally interested in the economic impact of preventative screening
- Decided to focus the study on Colorectal Cancer
 - 68% of Americans 50+ are screened for CRC

Literature/Sources

- *State Cancer Profiles*, Centers for Disease Control and Prevention (CDC)
 - Provided accurate incidence and mortality rates by state
- *CRC: Facts and Figures*, American Cancer Society
 - Best source, included everything from treatment options to screening numbers
- *Colon and Rectal Treatment Options*, The U.S. Oncology Network
- *CRC on the Decline*, New England Journal of Medicine

CRC Mortality Rates

	Mortality Rate per 100,000 2013	Mortality Rate per 100,000 2016	Percent Change	National Mortality Rate 2016	Variation from National Average	Screening Rates (Adults 50+)
Massachusetts	13.8	12.9	(6.52%)	15.1	(14.57%)	76%
New Hampshire	13.7	13.0	(5.11%)	15.1	(13.91%)	74%
Vermont	14.3	14.2	(0.70%)	15.1	(5.96%)	71%
North Dakota	15.6	15.7	0.64%	15.1	3.97%	64%
South Dakota	16.6	15.7	(5.42%)	15.1	3.97%	67%
Iowa	16.4	15.5	(5.49%)	15.1	2.65%	68%
Minnesota	13.5	12.8	(5.19%)	15.1	(15.23%)	72%

(CRC: Facts and Figures 17) (State Cancer Profiles) (CRC by State)

Conclusion

- There is a negative correlation between screening rates and cancer rates
- This could be a direct reflection of the success of preventative screening or it could just be statistical lineage
- 59.6% of 50+ yr olds with health care coverage were screened and only 25.1% of 50+ yr olds without (American Cancer Society 2014)
- Further research is needed under a controlled experiment (which is unrealistic) in order to definitively say that preventative screenings reduce CRC rates