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Formulating effective and accessible population-based colorectal cancer screening programs

Danielle Luffman
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Formulating effective and accessible population-based colorectal cancer screening
programs

Danielle Luffman

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SIT Global Health and Development Policy

Academic Director Alexander Lambert

University of North Carolina

Biology BS, Global Studies BA

Abstract

Colorectal cancer, a type of carcinoma originating in cells of the colon or rectum, continues to rank as the third most prevalent cancer worldwide with 1.36 million cases and the fourth most fatal with 693,881 deaths during 2012. In an attempt to alleviate the burden of colorectal cancer throughout society, governments and non-governmental organizations continue to implement population-based cancer screening programs. These programs, typically designed by a federal authority, offer free screening tests to a given population for a certain type of cancer on a routine basis. National systematic screening programs have effectively reduced the incidence of and mortality from colorectal cancer in several countries. This paper specifically focuses on programs related to colorectal cancer screening, which offer various types of testing depending on the population. As colorectal cancer screening programs remain primarily nationally-based rather than international, few guidelines have been established relating to the design of systematic colorectal cancer screening programs. This paper first highlights the need for colorectal cancer screening programs, then addresses barriers to individual and national screening, and finally evaluates characteristics and components of successful colorectal programs in the global context with a goal to establish recommended guidelines in designing such programs.

Preface

No, I have not chosen to research cancer because I *like* the thought of an unforeseen disease potentially ending someone's life within days of diagnosis. No one *likes* anything involving cancer. However, I *relish* the opportunity to research ways to allow people to have more birthdays and years of life through cancer prevention and

treatment options. My fascination with one of the most prevalent and merciless killers began in middle school I suppose. I began volunteering in the hospital and at a nursing home at an early age, witnessing the stages of cancer progression first-hand. I continued my volunteer work at the Pediatric Hematology-Oncology Clinic at the University of North Carolina Lineberger Comprehensive Cancer Center in college. Paired with children undergoing cancer treatment, I shared in the months of low ANC counts where they stayed isolated in a hospital room, days filled with vomiting as a result of heavy chemotherapy doses, the weak days and the bad days, and the miraculous day when white blood cell counts began to increase after bone marrow transplants. It intrigued me that the rollercoaster ride which people refer to as cancer could be prevented in certain circumstances. Through screening and healthy behaviors, thousands of cancers are prevented annually. Thousands of more birthdays are celebrated every year. I have an incredible opportunity to prevent the number of lives taken by cancer annually through my research of colorectal cancer screening programs. I hope my research will aid in establishing formal guidelines for designing national screening programs and encourage governments to see the need for entire populations to be screened routinely for colorectal cancer. My research drives me to wake up each morning and continue sifting through countless clinical trials and studies involving alternative treatment options and new screening techniques, that perhaps more people can wake up each morning too.

Acknowledgments

I would like to thank the children with whom I volunteer in the Pediatric Hematology-Oncology Clinic at the University of North Carolina Lineberger Comprehensive Cancer Center for motivating me to seek out ways to celebrate more

birthdays with them every year and allowing me to share in the little joys of everyday. I would also like to thank Dr. Rodolfo Gomez Ponce de Leon, Dr. Irene Garbero, and Lucia Gomez Garbero of the Ministry of Health of Tucumán, Argentina for inspiring me to pursue colorectal cancer screening research. I would like to thank my mother, Becki Luffman, for allowing me to study abroad in Switzerland, funding me, and her continual support. I would like to thank my father, Mike Luffman, for his continued support in all my interests and unwavering love. I also wish to acknowledge my brother, Nash Luffman, for quick wit that always keeps life in perspective. Lastly, I would like to acknowledge the gift the School of International Training has given me in allowing me to research what I love for the past two months. This gift has not only contributed to my academic studies but also helped me define the purpose of my future career.

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Introduction and Literature Review

Dating back to 370 BC, the word “cancer” has evolved to describe a set of diseases in which abnormal cells rapidly divide and invade other tissues without control, spreading throughout the body. Hippocrates used the terms *carcinomas* and *carcinoma* to describe the crab-like projections from non-ulcer forming and ulcer-forming tumors during 460-370 BC. Celsus, a Roman physician from 28-50 BC, translated the term into *cancer*, the Latin word for crab¹. Centuries later, the word “cancer” continues to provoke feelings of emotional grief, distress, pain, curiosity, uncertainty, and question throughout society. Cancer persists as the leading cause of death worldwide with 8.2 million deaths and 14.1 million new cases in 2012². Today, researchers and medical experts have discovered over one hundred types of cancer whose names derive from the organ or type of cell in which they start. When grouped, cancers loosely fit into five main categories- carcinoma, sarcoma, leukemia, lymphoma and myeloma, and central nervous system cancers. Generally cancer originates when damaged DNA produces mutations affecting normal cell growth and division in skin cells, tissue cells, or cells lining internal organs in carcinomas³.

Colorectal cancer, a type of carcinoma originating in cells of the colon or rectum, continues to rank as the third most prevalent cancer with 1.36 million new cases and the fourth most fatal with 693,881 deaths worldwide during 2012⁴. It remains important to

¹ "The History of Cancer." (n.d.): n. pag. American Cancer Society, 12 June 2014. Web. 13 Oct. 2014. <<http://www.cancer.org/acs/groups/cid/documents/webcontent/002048-pdf.pdf>>.

² "Press Release- Latest World Cancer Statistics." (2013): 1-3. *International Agency for Research on Cancer*. World Health Organization, 12 Dec. 2013. Web. 13 Oct. 2014. <http://www.iarc.fr/en/media-centre/pr/2013/pdfs/pr223_E.pdf>.

³ "What Is Cancer?" National Cancer Institute, n.d. Web. 11 Oct. 2014. <<http://www.cancer.gov/cancertopics/cancerlibrary/what-is-cancer>>.

⁴ "Worldwide Cancer Mortality Statistics." Cancer Research UK, 14 Feb. 2014. Web. 13 Oct. 2014. <<http://www.cancerresearchuk.org/cancer-info/cancerstats/world/mortality/#Common>>.

understand where colorectal cancers appear. The colon starts at the end of the small intestine, the cecum, and continues as the ascending, transverse, descending, and sigmoid colon. From the sigmoid colon, the rectum starts and extends as the last six inches of the digestive system opening at the anus. The majority of diagnosed colorectal cancers start as polyps in the inner lining of the colon or rectum and grow toward the center. Certain types of polyps, adenomas, resemble the lining of the colon or rectum but differ by composition. Adenomas may remain non-cancerous for an extended period of time before developing cancerous characteristics. Over ninety-five percent of colon and rectal cancers diagnosed appear as adenocarcinomas, polyps that begin in the gland cells lining the inside of the colon or rectum⁵.

Historically, cancer has the highest prevalence in developed countries such as Australia, the United States, and France. Researchers have observed an increase in prevalence of colorectal cancer over the past several decades in Western countries due to factors such as physical inactivity, obesity, and environmental factors. Croatia, Hungary, and Czech Republic contain the highest mortality rates worldwide for colorectal cancer. Hungary has the highest mortality rate at 20.79 percent⁶. In Africa, South America, and Asia, colorectal cancer remains one of the least diagnosed cancers. Due to the lack of screening, there has been a false perception of historically low incidences of colorectal cancer in countries in these regions. However, researchers have seen a transformation of a traditionally developed-country disease to an increasing prevalence amongst resource-

⁵ "What Is Colorectal Cancer?" American Cancer Society, 31 Jan. 2014. Web. 10 Oct. 2014. <<http://www.cancer.org/cancer/colonandrectumcancer/overviewguide/colorectal-cancer-overview-what-is-colorectal-cancer>>.

⁶ "Worldwide Cancer Mortality Statistics." Cancer Research UK, n.d. Web. 13 Oct. 2014. <<http://www.cancerresearchuk.org/cancer-info/cancerstats/world/mortality/#Common>>.

poor countries⁷. Thus, the prevalence of colorectal cancer proves a burden to the international community.

The prevalence and mortality of colorectal cancer depends on the stage of diagnosis. Screening and early detection programs remain essential in the global fight against colorectal cancer to detect cancerous polyps at earlier stages. Screening, as best defined by the World Health Organization, refers to “the presumptive identification of unrecognized disease or defects by means of tests, examinations, or other procedures that can be applied rapidly”⁸. Thus, systematic colorectal cancer screening allows for non-cancerous polyps to be detected and removed before they become malignant and cancerous adenomas to be removed at earlier stages through examinations and testing. Colorectal cancer screening potentially prevents malignant cancer from developing by detection of polyps and abnormal growths in the colon and rectum. Access to early detection services and screening proves one of the most effective ways in reducing the mortality rate of colorectal cancer globally. Screening programs ensure the high-risk population in a given area has access to quality, affordable (if not free), routine, and reliable testing services.

Cancer screening programs refer to programs designed by typically a federal authority to offer free screening tests for a certain type of cancer to the population on a routine basis. Screening programs have effectively reduced the incidence and mortality due to several types of cancer in various countries. The most common population-based cancer screening programs relate to prostate and breast cancer. Colorectal cancer

⁷ Center, MM, A. Jemal, RA Smith, and E. Ward. "Worldwide Variations in Colorectal Cancer." *PubMed*. U.S. National Library of Medicine, Dec. 2009. Web. 13 Oct. 2014. <<http://www.ncbi.nlm.nih.gov/pubmed/19897840>>.

⁸ "Screening for Various Cancers." World Health Organization, n.d. Web. 22 Oct. 2014. <<http://www.who.int/cancer/detection/variouscancer/en/>>.

screening programs remain less prevalent because of the invasive nature of endoscopies, financial burden, lack of a commonly accepted method of screening by researchers, and other barriers to screening. However medical experts and researchers agree that given an incidence of 1.36 million new cases annually, there exists a significant need for implementation of more systematic screening programs.

First off, this paper attempts to highlight the need for and impact of colorectal cancer screening programs by highlighting the correlation between implementation of systematic colorectal cancer screening programs the decrease in incidence and mortality of colorectal cancer. Furthermore, the paper aims to evaluate the components and characteristics of population-based colorectal cancer screening programs which prove effective in reducing the incidence and mortality rate of colorectal cancer in a population. The paper evaluates characteristics and components of successful screening programs in an effort to establish recommended guidelines in designing such programs. This paper will use Switzerland, Argentina, and Ireland as case studies in stages of development of population-based colorectal cancer screening programs and throughout the paper. This paper may use the terms *systematic*, *population-based*, and *national* interchangeably when referring to colorectal cancer screening programs. The majority of colorectal cancer screening programs deliver testing on a routine basis (systematic), take into account population demographics (population-based), and implemented by the federal government (national). Although not necessarily accurate, these terms coincide throughout the paper. The question exists: what components of population-based colorectal cancer screening programs make them both accessible and effective in reducing the burden of colorectal cancer in a society?

Methodology and Analytical Framework

The approach used in an attempt to answer the research question consisted of primary and secondary data sources. Since a large amount of data exists on the burden of cancer on society, secondary sources aided in providing background to the question. Publications and statistical reports from governmental, international, and non-governmental organizations such as the World Health Organization, Federal Office of Public Health, Cancer Research UK, American Cancer Society, and PubMed were referenced in an attempt to quantify the need for screening programs. A quantitative approach was used to determine the amount of burden colorectal cancer places on society and the impact systematic screening programs have in alleviating the burden. Primary sources consisted of medical experts and researchers on colorectal cancer and gave more of a qualitative approach. Interviewees Urs Marbet, Julien Stahelin, Idris Guessous, Clare Manning, and Lucia Gomez Garbero were located via their publications and work in designing colorectal cancer screening programs. They were then contacted via email and interviewed in-person with the exception of Garbero as she resides in Argentina. Several of the interviewees recommended referencing their own publications, as well as others, to gain a better understanding of the current approach of colorectal cancer screening programs. The quantitative data from secondary sources and the qualitative data from primary sources were then combined to produce an analysis of the overall problem and form a set of recommended guidelines in designing a program as a solution to the burden of colorectal cancer. Few ethical considerations existed throughout the study as medical professionals and researchers do not constitute vulnerable populations by most research

ethics committees. Copyrighted publications and unpublished raw data was cited, thus respecting the privacy of researchers.

The framework of this paper is structured so that the need for colorectal cancer screening programs is highlighted by examining the history, prevalence, and morality of colorectal cancer. After defining the need for such programs, the barriers to development of programs and stages of development are examined via case studies. Lastly, guidelines on development of programs are established in the third part of the paper. In the last part, the paper clearly establishes effective components and characteristics of colorectal cancer screening programs taking into account the first two-thirds of the paper.

Predispositions and defining the high-risk population

Overall researchers estimate more than one in three people will develop some type of cancer in their lifetime. In the United Kingdom in 2010, one in 13.7 men developed colorectal cancer and one in 17.8 women. According to this data, researchers predict by 2030 men in the United Kingdom will have a eight percent risk of developing colorectal cancer in their lifetime and women will have a seven percent risk. The risk of developing colorectal cancer continues to steadily increase from the first census taken by the Cancer Research UK in 1975⁹. These statistics represent the risk presented to the general population of the United Kingdom but give a good representation of the general risk, however as with all diseases some populations have higher risk than others.

Lifestyle habits and personal characteristics subject certain people to a higher risk of developing colorectal cancer than others. Researchers have found one of the largest factors in colorectal cancer prevalence remains age when detected. Of the cases detected,

⁹ "Lifetime Risk of Cancer." Cancer Research UK, 19 Dec. 2012. Web. 13 Oct. 2014.
<<http://www.cancerresearchuk.org/cancer-info/cancerstats/incidence/risk/statistics-on-the-risk-of-developing-cancer#What>>.

people over fifty years old account for ninety percent. Less pronounced, men have a slightly larger risk of developing colorectal cancer. Smoking, physical inactivity, heavy alcohol use, obesity, and personal history of cancers all put people at higher risk of developing colorectal cancer. Black people have the highest incidence of colorectal cancer of all races. Ashkenazi Jews have the highest incident rate in the world, about six percent of this ethnic group has a mutation in the gene I1307K APC which predisposes them to cancerous polyp formation. If a person has a family member that was diagnosed with colorectal cancer before the age of sixty, the person has nearly double the chance of developing colorectal cancer. Personal history of adenomas and inflammatory bowel disease, such as Crohn's disease or ulcerative colitis, also put people at higher risk of incidence¹⁰.

Certain inherited conditions put subpopulations at higher risk for colorectal cancer development than others. Familial adenomatous polyposis (FAP) and hereditary nonpolyposis colorectal cancer (Lynch syndrome or HNPCC) predispose those who have inherited the syndromes to developing colorectal cancer. FAP accounts for one percent of all diagnosed cases and is a rare disorder which causes a lot of small noncancerous polyps in the large bowel, some of which can develop into cancer by the age of forty or fifty¹⁰. Doctors recommend people with FAP have their entire colon surgically removed before the age of 25 as it proves almost certain they will develop cancer by 50. HNPCC accounts for one to four percent of diagnosed cases and acts as a faulty gene for DNA repair. People with HNPCC have increased risk for several cancers, but the highest risk remains development of colorectal cancer at a young age. Other conditions which

¹⁰ "Colorectal Cancer: Risk Factors and Prevention." *Cancer.net*. American Society of Clinical Oncology, n.d. Web. 13 Oct. 2014. <<http://www.cancer.net/cancer-types/colorectal-cancer/risk-factors-and-prevention>>.

predispose people to cancerous polyp development include Turcot syndrome, Peutz-Jeghers syndrome, MUTYH-associated polyposis, and Type II diabetes¹⁰.

One characteristic of effective colorectal cancer screening programs involves targeting screening of the general population but also having specific guidelines and regulations related to high-risk populations. Inherited conditions and lifestyle habits put select individuals at higher risk for developing colorectal cancer than others. These individuals require frequent screening to prevent the abrupt development of a cancerous adenoma. High-risk populations, including those with poor lifestyle behaviors and genetically-inherited conditions, may require screening before the accepted age at which testing for colorectal cancer commences. Advocacy of conditions and behaviors which predispose people to a higher risk of developing colorectal cancer remains a cornerstone of effective screening programs, highlighting the importance of regular and frequent testing for high-risk populations. In conclusion, experts must collect data on the prevalence of poor lifestyle habits and preexisting conditions when designing a screening program to effectively reduce colorectal cancer mortality.

Screening options

Researchers agree colorectal cancer persists as one of the most preventable cancers through early detection, yet remains one of the most prevalent because of lack of screening. Early detection of colorectal cancer occurs primarily through screening of the colon and rectum and looking at the normal structure to detect any abnormal growths, such as polyps. One of the most important components in colorectal cancer screening programs remains determining which screening options the program should offer the population. The private and public sectors commonly find determining and agreeing on

the most effective, sensitive, inexpensive, and reliable screening options to offer to the general population a difficult task. The most sensitive test usually proves the most expensive and invasive and the less expensive options prove more unreliable but more accessible.

Colorectal screening generally proves cost-effective in that it remains less expensive to remove a polyp during regular screening than fund treatment of advanced stages of colorectal cancer. Colorectal screening tests occur in a number of ways— invasively, using feces samples, external scans, or x-rays. The most common types of screening include colonoscopy, fecal occult blood test, flexible sigmoidoscopy, double contrast barium enema, CT colonography, and a fecal immunochemical test. Some less invasive tests only detect cancer, yet others detect both cancer and pre-cancerous polyps which when removed, will not develop into cancer. All screening options discussed in this section have proven to reduce the mortality due to colorectal cancer if implemented on a regular basis in accordance with quality guidelines. Table I, a table taken from the National Cancer Institute, displays the effect of certain colorectal screening options in reducing mortality from colorectal cancer¹¹. An important component of effective colorectal cancer screening programs remains selecting a screening test or examination which proves most effective within a population, both in terms of sensitivity of the test and compliance by the population.

¹¹ "Colorectal Cancer Screening (PDQ®)." National Cancer Institute, n.d. Web. 22 Oct. 2014. <<http://www.cancer.gov/cancertopics/pdq/screening/colorectal/HealthProfessional/page1>>.

Table I. Mortality and colorectal screening interventions

Table 1. Effect of Screening Intervention on Reducing Mortality from Colorectal Cancer^a

[Enlarge](#)

Screening Intervention	Study Design	Internal Validity	Consistency	Magnitude of Effects	External Validity
Fecal Occult Blood Test	RCTs	Good	Good	15%–33%	Fair
Sigmoidoscopy	Case-control studies, ^[1] RCTs in progress	Fair	Fair	About 60%–70% for left colon	Fair
Digital Rectal Exam	Case-control studies	Fair	Good	No effect	Poor
Colonoscopy	Case-control studies, RCTs in progress	Poor	Poor	About 60%–70% for left colon; uncertain for right colon	Fair

RCT = randomized controlled trial.

^a*There are no data on the effect of other screening interventions (i.e., fecal occult blood test combined with sigmoidoscopy, barium enema, colonoscopy, computed tomographic colonography, and stool DNA mutation tests) on mortality from colorectal cancer.*

Screening options which primarily detect colorectal cancer include the fecal occult blood test (FOBT) and fecal immunochemical test (FIT). FOBTs detect invisible blood in the feces indicative of fragile blood vessels on the exterior of polyps which rupture when feces pass. The patient completes the test kit, prescribed by the doctor, at home by collecting samples from three consecutive bowel movements. The samples are then returned to the laboratory and undergo chemical reactions to detect any blood. The test does not specify where the blood originated from and for this reason, if blood is found, a colonoscopy must be preformed. The test proves non-invasive, has no direct risks to the colon, private in preforming it in the security of the home, and inexpensive. However, the test must be repeated every year, has a high false-positive rate and dietary limitations pre-test, requires a colonoscopy if the test is abnormal and repetition every year¹². The pilot

¹² "Colorectal Cancer Screening Tests." American Cancer Society, 6 June 2014. Web. 21 Oct. 2014. <<http://www.cancer.org/cancer/colonandrectumcancer/moreinformation/colonandrectumcancerearlydetection/colorectal-cancer-early-detection-screening-tests-used>>.

program in Uri offers FOBTs as one of the testing options in systematic screening program¹³.

The FIT reacts to parts of the human hemoglobin protein in the same manner as the fecal occult blood test. In the same way as an FOBT, a colonoscopy must be preformed if blood is detected¹⁴. This test does not have dietary restrictions, has no direct risk to the colon, sampling occurs in the home, and proves an inexpensive option. Ireland has chosen to offer FITs in their national screening program as the test proves inexpensive and has less false-positive results than FOBTs. Both the FOBT and FIT prove less sensitive than invasive testing, one must repeat every year, and the tests produce more false positives than the subsequent four tests. However, FOBTs and FITs do not have bowel preparation and prove less expensive and invasive than the subsequent four options.

Tests which detect colorectal polyps and cancer include a flexible sigmoidoscopy, colonoscopy, double-contrast barium enema, and CT colonography (virtual). In a flexible sigmoidoscopy, the doctor inserts a tube with a small camera on the end, a sigmoidoscope, in through the rectum in order to view the entire rectum. However due to its length, the sigmoidoscope can only view less than half of the colon. Preparation for the procedure includes laxatives or enemas as the colon must be clear of all waste prior to the procedure. During the procedure, the doctor blows air into the sigmoid colon to have a closer look at the colon lining. A small instrument passes through the scope to remove any abnormalities which are then sent to the laboratory, if necessary. Pros to flexible sigmoidoscopies include no sedation, only preformed every five years, does not require a

¹³ Urs, Marbet. Personal interview.

¹⁴ "Colorectal Cancer Prevention and Early Detection." (n.d.): n. pag. American Cancer Society, 6 June 2014. Web. 13 Oct. 2014. <<http://www.cancer.org/acs/groups/cid/documents/webcontent/003170-pdf.pdf>>.

specialist nor full bowel preparation, and proves quick and safe. However, sigmoidoscopies only view a third of the colon, do not detect nor can remove several polyps, provides some discomfort, and a colonoscopy will follow if abnormal results exist¹². The United Kingdom will introduce flexible sigmoidoscopies as part of their National Cancer Screening Program in 2016 after a trial showed a 50 percent reduction in mortality due to colorectal cancer if screened over an 11-year period¹⁵.

A colonoscopy, perhaps the most common of the tests, involves a longer version of the sigmoidoscope, a colonoscope, but the same preparation and process. Sedation, a small risk of bleeding or tears in the lining of the colorectal tract, and extensive bowel preparation prove more common with a colonoscopy as the physician examines the entire colon and rectum. The physician examines the inner walls of the colon and preforms a biopsy if he or she detects a larger tumor of concern. Experts recommend to repeat the test every ten years as the test produces few false positives¹². Historically, the international community accepts colonoscopies as the most common and reliable method for colon screening. However, colonoscopies remain one of the most expensive options on a one-time basis and thus not all patients can afford them if they lack health coverage. As of current, no national program offers colonoscopies as the primary test for the general population. However, almost all screening programs in which FOBTs prove abnormal then refer patients to a colonoscopy and cover the cost.

In a double-contrast barium enema (DCBE), the physician passes barium sulfate through a flexible tube which he or she inserts through the rectum. When the colon is half-full of barium, air is inserted into the colon to make the barium sulfate cover the

¹⁵ Robb, K. A. "Patient-reported Outcomes following Flexible Sigmoidoscopy." *National Center for Biotechnology Information*. U.S. National Library of Medicine, 19 Dec. 2012. Web. 1 Nov. 2014.

entire lining. The physician then takes x-ray images of the colon and rectum. DCBEs require full bowel preparation, result in some false positives, cannot remove polyps during testing, and require a colonoscopy if abnormal results appear. Experts recommend to repeat DCBEs every five years as DCBEs view the entire colon, do not require sedation, and prove relatively safe¹². Currently, no population-based screening programs choose DCBEs as the offered screening test. One study concluded significantly more training for physicians and medical professionals would have to occur in order to accurately detect and diagnose colorectal cancer via DCBEs¹⁶.

Lastly, in a CT (virtual) colonography, the physician inserts a tube through the rectum and fills it with air before taking a CT scan, or several two-dimensional and three-dimensional pictures of the colon and rectum. The patient lies on table, slides into a CT scanner, and holds his or her breath while scans are taken¹⁷. Although this procedure appears less invasive than colonoscopies and does not require sedation, it also requires extensive bowel preparation. Experts recommend patients repeat virtual colonoscopies every five years as they prove fairly quick and safe and view the entire colon. However, the test produces some false positives and a follow-up colonoscopy proves necessary if results appear abnormal in order to examine the lining more closely and remove any abnormalities. The virtual colonoscopy remains fairly new in the field of colon screening and thus not all insurance companies fund it. Currently no population-based colorectal cancer screening programs use virtual colonographies.

¹⁶ Halligan, S., and M. Marshall. "Observer Variation in the Detection of Colorectal Neoplasia on Double-contrast Barium Enema." Elsevier, 21 May 2003. Web. 20 Oct. 2014. <<http://www.sciencedirect.com/science/article/pii/S0009926003003179>>.

¹⁷ "Colorectal Cancer Prevention and Early Detection." (n.d.): n. pag. American Cancer Society, 6 June 2014. Web. 13 Oct. 2014. <<http://www.cancer.org/acs/groups/cid/documents/webcontent/003170-pdf.pdf>>.

No standard guidelines for colorectal cancer screening exist as to which options prove the most sensitive, reliable, and cost-effective. According to David Lieberman, “The optimal form of screening is not clear. Fecal screening tests can be performed at home at low initial cost, but current versions lack high sensitivity for cancer precursor lesions, and tests need to be repeated at regular intervals”¹⁸. Furthermore, he highlights the importance of adherence to regular testing and follow-up colonoscopies to positive tests. Generally speaking, FOBTs and colonoscopies prove the most common options to offer in a population-based screening program due to affordability, accessibility, and validity from several research studies. In comparison to FOBTs and colonoscopies, the other methods appear relatively new to the market and have less confidence from the general population. All methods prove to reduce colorectal cancer mortality when undergone routinely. Choosing the right screening option to offer a population must take into account the cost of each test, how often the population must repeat the test offered, the general confidence in the testing method, human resources and capital for mass deliverance of the test, the correlation between adherence to the test and preparation procedures, sensitivity of the test, and several other factors. Ultimately the effectiveness of any systematic screening program depends on the quality of and adherence to any chosen type of screening test.

Barriers to screening

In designing a population-based screening program, experts must address and overcome individual and population-based barriers to colorectal cancer screening.

Without consideration of barriers, a well-designed program could ultimately fail due to

¹⁸ Lieberman, David. "Progress and Challenges in Colorectal Cancer Screening and Surveillance." *GastroJournal*. Division of Gastroenterology and Hepatology, Oregon Health and Science University, 18 Feb. 2010. Web. 21 Oct. 2014. <[http://www.gastrojournal.org/article/S0016-5085\(10\)00178-2/fulltext](http://www.gastrojournal.org/article/S0016-5085(10)00178-2/fulltext)>.

noncompliance by the population. Although screening dramatically decreases the mortality rate and prevalence of advanced stages of colorectal cancer, only half of the people aged fifty and older have access to screening options in the United States¹⁹.

The three main individual barriers in the United States population which prevent individuals from accessing early detection services include lack of financial resources, insurance options, and lack of public health awareness related to screening tools.

Colonoscopies and FOBTs prove quite expensive without insurance coverage.

Colonoscopies range from USD\$2,010 to USD\$3,764 and FOBTs average USD\$5 to USD\$20 in the United States^{20,21}. Depending on the geographical region and insurance coverage screening costs vary dramatically. Thus with the commencement of the financial crisis in 2008, many patients continue to forgo colorectal cancer screening due to lack of financial resources. A colorectal cancer screening program must possess the financial capital to provide all patients in need of screening, regardless of individual income, a testing option. Thus, expert must take into consideration where the financial capital will come from. Secondly, the commonness of screening throughout a society directly relates to the health coverage of screening services under the health insurance system. If health insurance policies cover the costs of colorectal cancer screening services, the probability patients will forgo screening due to lack of financial resources proves relatively low. However in the face of lack of health insurance due to unemployment or other extenuating circumstances, the general population demonstrates reluctance to cover the out-of-pocket expenses of screening services. In 2013,

¹⁹ "Colorectal Cancer Facts & Figures." American Cancer Society, 2011. Web. 2 Nov. 2014.

²⁰ "How Much Does a Colonoscopy Cost?" CostHelper, n.d. Web. 20 Oct. 2014.
<<http://health.costhelper.com/colonoscopy.html>>.

²¹ Aleea, Khan. "The Role of Fecal Occult Blood Testing in Colorectal Cancer Screening « NCI Benchmarks." *NCI Benchmarks*. N.p., 26 Mar. 2010. Web. 19 Nov. 2014.

Switzerland mandated health insurance companies cover colonoscopies every ten years and FOBTs every two years between the ages of 50 and 69²². Idris Guessous of HUG said he remains unsure if coverage of colorectal cancer screening services under the new health insurance mandate will have a significant impact on the popularity of screening within Switzerland²³. Prior to the new health insurance mandate, Swiss patients requiring colon screening services for suspected issues such as colon or rectal cancer received a mandate from their physician requiring their health insurance company to cover such tests. Therefore, although federal law did not require health insurance companies to cover screening services many service were covered without legislation²⁰. The overall trend does prove increasing health insurance coverage of screening services generally increases the proportion of the population screened due to alleviation of financial burden.

In addition to individual barriers, barriers exists throughout a population in regards to colorectal cancer screening. A wide gap in knowledge of the importance of screening and consequences of lack of adherence to irregular screening exists in developed and developing societies today. Although the majority of society has an awareness of the burden of cancer in society, a large proportion do not realize the extent to which colorectal cancer screening can alleviate the burden of cancer. According to Guessous, the role of the government in advocacy for screening in Switzerland remains very low as society perceives health as a personal responsibility²⁰. Low advocacy and lack of educational trainings for the general population by governmental and non-governmental organizations proves a significant barrier in universal screening. According to Urs Marbet of Kantonsspital Uri, during the initial years of the canton-based colorectal

²² Staehelin, Julein. Personal interview.

²³ Guessous, Idris. Personal interview.

cancer screening program cultural stigma presented a significant challenge to the success of the program¹³. Many individuals were initially reluctant to participate in the program because of the discomfort of the test, potentially positive results, and invasive nature of colonoscopies. Only 12 percent of contacted, eligible individuals participated in the program the first year. However, as the screening program demonstrated a reduction in mortality due to colorectal cancer society gradually accepted and adhered to the program¹³. In terms of population barriers to implementation of national colorectal cancer screening programs, policy makers must analyze the cost-effectiveness of implementing a population-based screening program.

Universal access to colorectal cancer screening daunts policy makers because of the enormous financial burden. The financial capital and human resources necessary for implementation of a screening program proves an obstacle in designing such a program. However in looking towards a population-based screening program, the World Health Organization (WHO) confirmed biannual FOBTs reduce colorectal cancer mortality by 20 percent and annual screening with has an even greater reduction²¹. Thus, research supports the enormous bearing a population-based screening program would have on cancer mortality. Thus a reduction in mortality alleviates the impact of cancer on the economy by allowing more able-bodied workers to contribute to society. In the long-run covering colorectal cancer screening services costs far less than cancer treatment if an individual develops colorectal cancer. Cancer treatment can cost upwards of tens of thousands of dollars, all depending on the length of the treatment period. Therefore if noncancerous polyps are detected through screening and subsequently removed, the healthcare system will suffer less from the high expenses of cancer treatment. The WHO

goes further to say without high compliance the program would not prove cost-effective²⁴. As the recommended timing between FOBTs remains quite often, researchers find low compliance in screening programs only offering FOBTs. In one study, only 42.1 percent of 384,525 men recruited performed a preliminary FOBT, 26 percent performed a second, and as little as 14.1 percent performed over four tests within five years. Women had an even lower compliance with only 13.7 percent undergoing four tests over five years²⁵. Reasons for not adhering to FOBTs include lack of education on the consequences of not being screened, lack of financial resources, and inconvenience in sampling and sending samples into the laboratory. Furthermore, undergoing FOBTs does not account for colonoscopies. With a sensitivity lower than 80 percent according to preliminary data and a high false-positive rate, a patient with colorectal cancer could go undetected with false negative results from FOBTs²⁶. Thus, researchers agree much work must be completed to improve the quality and sensitivity of FOBTs. Additionally, if an FOBT results in a positive outcome a colonoscopy remains necessary to remove the polyp. Some patients advocate for only a colonoscopy every ten years and forgo any FOBTs due to the frequency of testing and lack of sensitivity.

Population-based screening programs

The establishment of population-based colorectal cancer screening programs must take into account the demographics of the population it will cater to. According to Guessous, analysis of socioeconomic data allows policy makers to design a screening

²⁴ "Screening for Colorectal Cancer." World Health Organization, n.d. Web. 16 Oct. 2014. <<http://www.who.int/cancer/detection/colorectalcancer/en/>>.

²⁵ Marbet, Urs. "Kolonkarzinom: Prävention." (n.d.): n. pag. Web. 16 Oct. 2014. <http://www.coloproct.ch/pdfs/download/Praevention-and-Screening-Facts-and-Fantasy_Prof.U.Marbet.pdf>.

²⁶ Ransohoff, David, and Lang Christopher. "On the Sensitivity of Fecal Occult Blood Test Screening for Colorectal Cancer." JNCI J National Cancer Institute, 1997. Web. 16 Oct. 2014. <<http://jnci.oxfordjournals.org/content/89/19/1392.long>>.

program ensuring the highest compliance of individuals. In a study analyzing the relation between demographic factors and the prevalence of colorectal cancer screening in Switzerland, five waves of surveys via phone calls to Swiss households were administered from 2007-2012. The surveys related the prevalence of recent colorectal screening of households in Switzerland to demographic factors such as marital status, education, income, and sex. The study found income and number of annual general practitioner visits were the two largest factors in determining if an individual was likely to undergo screening²⁰. Therefore, as demographic factors vary from country to country there cannot exist a one-size-fits-all recipe for population-based screening programs. In the establishment of a population-based screening program, experts must account for compliance, adherence, feasibility, cost, allocation of resources, and harm to healthy persons²⁷. The government must decide which tests they view most appropriate and cost-effective based on analysis of demographic factors and existing barriers to screening. Additionally, the government must decide where the funds and resources to support the program will come from. Thus, it remains extremely difficult to design a program which policy makers, the private sector, and the public sector all agree on. Few countries have implemented such programs, however Ireland and Argentina provide good examples of successful population-based programs.

As the second most common cancer in Ireland with over 2,500 cases annually, in 2007 the government of Ireland decided to implement a phased-based national colorectal cancer screening program, BowelScreen. According to the mission statement, “BowelScreen aims to reduce the mortality from bowel cancer amongst the eligible

²⁷ Marbet, Urs. "Kolonkarzinom: Prävention." (n.d.): n. pag. Web. 16 Oct. 2014. <http://www.coloproct.ch/pdfs/download/Praevention-and-Screening-Facts-and-Fantasy_Prof.U.Marbet.pdf>.

asymptomatic population”²⁸. The National Cancer Screening Service (NCSS) of Ireland implemented BowelScreen in 2007 which offers men and women aged 60-69 a free fecal immunochemical test every two years. Ireland remains one of the only counties to utilize the fecal immunochemical tests over fecal occult blood tests. Designed on a phased basis, the program will expand to cater to ages 55 to 74 years of age. In alliance with the Department of Social Protection, the program has a database of eligible citizens to which it sends an invitation to encouraging them to participate in the free FIT. According to Clare Manning, spokeswoman for BowelScreen, individuals eligible for free tests will receive an invitation to participate and if they choose to register, they are sent a BowelScreen Home Test Kit by mail²⁹. The participants then return the samples via a pre-paid envelope and receive results via mail in four weeks. If the test proves positive, the individual will be offered a colonoscopy at a hospital contracted by the NCSS and assigned a nurse who will guide them through the process. The program is in accordance with the Quality Assurance Guidelines for Colorectal Screening and a Clinical Advisory Group supports the on-going development of the program. Professor Diarmuid O’Donoghue, Clinical Lead of BowelScreen, insists the effectiveness of the national screening program depends on the participation and education of the entire population²⁸. In 2015, the first round of invitations sent to eligible individuals will conclude and analysts will begin examining preliminary data on the effectiveness on the program. As part of the first phase, officials continue to better identify the target population, recruit individuals via phone call, deliver tests, analyze tests, and recalling individuals if follow-up tests prove necessary²⁸. Officials expect a larger reduction in mortality and the

²⁸ "BowelScreen." The National Cancer Screening Service, n.d. <<http://www.bowelscreen.ie>>. 1 Nov. 2014.

²⁹ Manning, Clare. Personal interview.

program to prove more cost-effective when the program expands to include all persons ages 55 to 74.

In an earlier stage of national screening program development, Argentina implemented a national colorectal cancer screening program in June 2014. According to Lucia Gomez-Garbero of the Ministry of Health of Argentina, the screening program offers asymptomatic patients aged 50 to 75 years old a FOBT and further refers them for a colonoscopy if results prove positive.³⁰ One important aspect of the program remains catering to the high-risk population. Patients with a history of colorectal cancer, Lynch Syndrome, or other cases which put individuals at higher risk than the average population bypass the FOBT and the program directly refers them to a colonoscopy, specialist, and genetic counseling. The program does offer FITs, colonoscopies, barium enema, and virtual colonoscopies in addition to FOBTs for free in hospitals if necessary. Financing of the program occurs from a bank loan from Interamericano Development and implementation of the program occurs by the Ministry of Health in coordination with the National Cancer Institute. In the preliminary months of implementation of the screening program, Gomez-Garbero acknowledges several obstacles. The two largest obstacles include strong compliance from the general population with implementation of the program and cooperation of physicians and health care providers. Physicians in the public sector continue to prove reluctant to offer services as they do not receive extra pay.

Effective components and development of systematic screening programs

Determining essential and effective components of population-based colorectal cancer screening programs proves difficult as demographic factors and resource-availability vary country to country. As previously discussed throughout the paper, a

³⁰ Gomez-Garbero, Lucia. Personal Interview.

successful program will prove cost-effective, accessible, acceptable by the scientific community and the general population, have an advocacy or education campaign, cater to the high-risk population, and ensure high adherence to the program.

From the data provided, a significant need for population-based colorectal screening programs exists globally. Taking into account previously discussed screening options, case studies of successful programs, and effective components of screening programs, designing an effective program with high compliance and adherence by the population proves difficult. National development occurs continuously in various private, public, and mixed sectors, however development transpires at slow rates due to passage of legislation and financial constraints. Typically a variety of actors participate in the development process at different stages. Development of population-based screening programs can be broken down into six stages—evaluation of need and initiation, data collection, analysis and negotiation, allocation of resources, implementation, and evaluation.

The first stage, evaluation of need and initiation, occurs when society demonstrates a need for screening service coverage and either society itself or organizations within society bring such necessity to the governments' attention. Depending on the country, different actors then advance on the need and take action. In Switzerland, health care administration resides at the canton-level. Therefore, it remains the responsibility of individual cantons and not the federal government to address the need for universal screening¹³. Without any national screening program in Switzerland, physicians in cantons Uri and Vaud have placed pressure on the regional government to implement pilot screening programs. Urs Marbet, president of the task force on colorectal

cancer, initiated the screening program in Uri in 2000. According to Marbet, physician-initiated programs prove more difficult since funding for population-based programs generally comes from the government¹³. However, canton governments of Basel and Lucerne have indicated interest in founding similar programs within the coming decade. Once either the government or individual personnel decide to undertake design of a screening program, they must analyze the demographics of the population in order to convince the government to finance the program, have high participation from the population, and construct the most effective program.

As with the Vaud socioeconomic study, demographic factors play a large role in the type of services to deliver. Data collection on population demographics may include phone and paper surveys, mass mailings, and statistical reports to determine which methods of screening best suit the population and which will ensure highest adherence. Demographic factors to consider in evaluation of the population include average age, sex ratio, marital statuses, average distance to an equipped endoscopy location, gross domestic product per capita, health insurance coverage, education, and frequency of general practitioner visits. According to a study on breast cancer screening programs in Sweden, sociodemographic factors exhibit a large influence on attendance and participation in cancer screening programs. Factors in the study including age, social support, employment status, and health behaviors such as smoking and self-related health all influenced attendance in the breast cancer screening program³¹. Experts ought to analyze similar sociodemographic factors to construct a tailored program for the population.

³¹ Lagerlund, Magdalena. Karolinska University Press, 2002. Web. 21 Oct. 2014.
<<https://publications.ki.se/xmlui/bitstream/handle/10616/38622/thesis.pdf?sequence=1>>.

After collecting data, experts must weigh different options to determine which screening options best suit the demographics of the community in accordance with cost-effectiveness and test sensitivity. In analyzing trends in demographic data as well as available resources, researchers decide on certain aspects of the program which may better suit the population. For example, if providing colonoscopies as the screening method to citizens will place stress on the infrastructure in a country, then perhaps at-home FOBT administration provides a more suitable option. Experts must also consider the populations' anticipated adherence to the screening option. Factors that play a large role in determining the most appropriate test to offer the population include potential harms of the test, preparation required for the test, necessary sedation, follow-up care after and convenience of the test, the population's average age, medical and family history, general health, and the cost and availability of the test given insurance coverage³². Experts must also decide where the financing for the program will come from, who will perform and where administration of invasive screening services will occur, and how resources to allocate resources. Negotiation between health insurance companies, private and public sectors, and the government must occur in order to choose the most cost-effective and presumably most beneficial screening options to offer. Generally speaking the government funds systematic cancer screening programs for the population. Funding by the government can occur in two ways; funding may require some negotiation with health insurance companies to extend coverage to a wider range of individuals and services offered or the government can directly finance and provide screening services to the general population.

³² "Tests to Detect Colorectal Cancer and Polyps." National Cancer Institute, n.d. Web. 21 Oct. 2014. <<http://www.cancer.gov/cancertopics/factsheet/detection/colorectal-screening>>.

Allocation of resources remains vital in ensuring the most successful program. With limited funding, experts must allocate economic, infrastructural, political, human, and social capital accordingly. Experts must invest economic resources into forms of quality care which are both accessible and applicable to the population. The current NHS Bowel Cancer Screening Program costs the United Kingdom government £77.3 million to screen people between 60 and 69 years old³³. Thus, the type of screening service offered must prove affordable for the government and cost-effective in reducing the colorectal cancer mortality rate. Infrastructure, such as hospitals and outpatient clinics, persists as an important determinant in effective systematic colorectal cancer screening programs. Without enough colonoscopes, medical beds, laboratory equipment, and hospitals, national governments will find it exceedingly difficult to run effective programs if the chosen screening option to offer (such as endoscopies) requires more infrastructure than currently exists in a country. Experts ought to evaluate the current political capital and ability to enact legislation in the political system regarding cancer screening programs. The provision of national advocacy campaigns also persist as a crucial determinant in a country before implementation of programs. According to Marbet, the federal government of Switzerland has not approved the legislation related to national advocacy for colorectal cancer screening due to administrative costs¹³. Thus, experts may need to locate alternative ways of advocacy prior to implementation to ensure the population receives proper education regarding the colorectal cancer screening program. Efficient allocation of human capital prior to implementation of a population-based colorectal cancer screening program remains another vital factor in program

³³ "How Much Does Bowel Screening Cost?" NHS, n.d. Web. 21 Oct. 2014. <<http://www.cancerscreening.nhs.uk/bowel/bowel-screening-cost.html>>.

success. Experts analyze the number of certified physicians who have the certifications to perform endoscopies and laboratory assistants who possess the training to analyze the results of FOBTs and FITs. Marbet mentioned one current challenge to the pilot program in Uri remains lack of physicians to carry out endoscopies¹³. Thus, recently a shift to FOBTs as preliminary screening measures followed by colonoscopies if results appear abnormal has occurred. Lastly, social capital provides a vital measure to ensure the success of a population-based colorectal cancer screening program. Social capital refers to “those tangible assets [that] count for most in the daily lives of people: namely goodwill, fellowship, sympathy, and social intercourse among the individuals and families who make up a social unit” according to author Lyda Hanifan³⁴. Thus, the fellowships and relationships within a social unit can have a significant impact on the success of a program in reducing mortality due to colorectal cancer by encouraging family members, friends, and coworkers to undergo screening. Once experts have analyzed how to allocate resources and capital most effectively, implementation of a population-based screening program has the ability to commence.

Implementation of screening programs remains the responsibility of the government and the founders of the program. In the screening program in Uri, the canton government mailed all citizens above 50 years of age with information regarding the free screening program, encouraged them to undergo screening, and if records displayed they did not comply with a free screening they were mailed again¹³. The campaign involved mailings, phone calls, and house-to-house education. Yet in the first year, only twelve percent of those who needed to undergo screening went in for a colonoscopy. However,

³⁴ "OECD Insights: Human Capital." *What Is Social Capital?* (n.d.): n. pag. OECD. Web. 21 Oct. 2014. <<http://www.oecd.org/insights/37966934.pdf>>.

the response rate has greatly improved as the programs' success has resounded throughout society. General practitioners serve as front-line advocates for referring the high-risk population to enroll or register in colorectal cancer screening programs. No mandate exists requiring people to comply with colorectal cancer screening programs and as such it remains a voluntary decision for individuals to undergo free screening. As seen in previous sections, several challenges occur within the initial phase of the programs and barriers to screening make the success of the programs difficult. Private, public, and governmental sectors must act as strong advocates for screening programs by educating the general population on the short- and long-term benefits of screening.

After designing and implementing a program, experts evaluate the effectiveness of the program over specific time periods. According to Marbet, an important aspect of well-designed screening programs proves having an assigned external group to analyze outcomes of the program¹³. The external group can evaluate the progress and impact the program had on the assigned population over time. If necessary, the external group can suggest modifications to the current program to better cater to the population. The external group also compiles reports demonstrating the importance of population-based screening programs to send to governmental and non-governmental grant sources.

Without evaluation of programs, the government may not see the importance of allocating resources, specifically funding, to screening programs. Lastly, as the programs expand and gain popularity experts may find it necessary to adjust policies and recommendations. After 14 years of implementation of the Uri program, colonoscopies have grown in popularity so there now exists a lack of physicians to administer endoscopies. Therefore, Marbet now encourages FOBTs in the general population¹³.

International organizations and colorectal cancer screening

Depending on the country international organizations can aid the ministry of health in establishment of a population-based colorectal cancer screening program and even assist in conducting the program in the long-term. However the majority of countries have little aid from international organizations as programs remain primarily government-based. The type of screening program needed varies significantly from country to country in accordance with population demographics, thus no international protocol for establishment of national colorectal cancer screening programs has been produced. International organizations do provide guidelines related to quality-assured testing and algorithms for predicting the high-risk population in a country. The WHO has produced several recommendations regarding screening for colorectal cancer. The WHO believes it is important for national cancer prevention programs to “avoid imposing the ‘high technology’ of the developed world on countries that lack the infrastructure and resources to use the technology appropriately or to achieve adequate coverage of the population”⁸. This specifically addresses the founding of national screening programs in countries which lack the infrastructure and personnel to adequately screen, diagnose, treat, and provide follow-up services for the population. Furthermore, the WHO recommends taking into account five aspects when choosing the offered screening method. In adopting a screening method, the WHO recommends considering sensitivity of the test, specificity (potential of negative results in negative individuals), positive predictive value, negative predictive value, and acceptability. However, even the most sensitive and specific tests may not detect cancer in positive individuals if the prevalence in society remains low⁸. The WHO does not advocate for installment of national

colorectal cancer screening programs in least developed countries where the infrastructure, low prevalence of cancer, and health care system cannot support a successful program⁸.

The WHO concludes that successful screening programs involve a prevalent form of cancer in the area, availability of effective treatment, and safe, acceptable, and inexpensive test procedures. Furthermore the WHO insists in national cancer control programs experts must reach an agreement on guidelines which will reach the largest proportion of the high-risk population by taking into account the frequency of screening, quality control systems for the tests, mechanisms for referral and treatment of abnormalities, and an information system. The information system should have the capacity to send out invitations for initial screenings, recall individuals for repeat screening, follow abnormalities, and monitor and evaluate the program. The program must take into account potential barriers, such as non-adherence of patients, and have defined mechanisms to deal with such challenges. Noncompliance must be dealt with in order to reduce wasting resources and improve the outcome of the program. Defining the high-risk group, including those with abnormal predispositions, proves a challenge in encompassing the entire population that needs screening⁸. Few international organizations have policies relating to national cancer screening programs as it primarily remains the responsibility of national governments to design effective programs tailored to the population in an area.

Conclusion

With over 8.3 million deaths globally due to cancer and 693,881 deaths due to colorectal cancer in 2012, a significant need for prevention of new cases exists within the

global community. Studies have proven colorectal cancer as one of the most preventable cancers through screening of the colon, yet it persists as one of the most prevalent and fatal cancers because of lack of screening. In countries where health insurance does not cover the majority of the population or colorectal cancer screening services, there exists a large need for implementation of population-based screening programs. Systematic screening programs offer the determined high-risk population a free test which screens for colorectal cancer on regular time intervals. Depending on the location either a group of physicians or the government initiate systematic screening programs. Systematic screening programs need to be population-based in their design, taking into account data collected on population demographics in a specific region. In this matter, experts can determine the high-risk population and choose the most effective screening test for the specific community. Funding for such programs proves quite hefty and is usually undertaken by the government in collaboration with health insurance companies. Typically, international organizations have little role in the implementation of systematic programs since population-based programs vary immensely from one country to another. International organizations do produce guidelines related to quality-assured testing and data statistics which prove useful in designing regulations for the program.

The correlation between increased colorectal cancer screening coverage and a decrease in mortality due to colorectal cancer may appear obvious. Implementation of more systematic, population-based programs would prove extremely beneficial to the alleviation of the global cancer burden. With cancer incidences continuing to rise more governments need to design and implement effective screening programs to ensure screening coverage of all high-risk citizens.

Abbreviation List

WHO- World Health Organization

HUG- Hôpitaux Universitaires de Genève

NCSS- National Cancer Screening Service

NHS- National Health Service

ANC- Automatic Nucleophile Count

DNA- Deoxyribonucleic Acid

APC- Adenomatous Polyposis Coli

FAP- Familial Adenomatous Polyposis

HNPCC- Hereditary Non-Polyposis Colorectal Cancer (lynch syndrome)

FOBT- Fecal Occult Blood Test

FIT- Fecal Immunochemical Test

DCBE- Double Contrast Barium Enema

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Danielle Luffman

September 3, 2014 Five hours of investigation of potential ISP topics at the United Nations Library

September 8, 2014 Emailed Sundhedsstyrelsen Monitorering & Medicinsk Teknologivurdering regarding accessibility and effectiveness of various types of colorectal screening programs globally- dead-end, no response

September 9, 2014 Submitted revised ISP proposal draft

September 9, 2014 Emailed Dr. Christine Bouchardy- referred to Dr. Idris Guessous

September 10, 2014 First ISP advising session

September 11, 2014 Emailed Dr. Jean-Bernard Daepfen regarding the Swiss take on colorectal cancer screening programs- dead-end, no response

September 11, 2014 Emailed Julien Staehelin regarding Swiss insurance coverage of colorectal cancer screening – in-person interview scheduled

September 11, 2014 Six hours of analysis and writing at the United Nations library

September 15, 2014 Emailed Dr. Idris Guessous for demographic data related to colorectal cancer screening- agreed to an in-person interview

September 16, 2014 Emailed the World Health Organization regarding project- dead-end, no response

September 16, 2014 Prepared 10 interview questions for Mr. Staehelin

September 17, 2014 Emailed Dr. Urs Marbet regarding the progress made in canton Uri in terms of establishing a canton-based screening program- in-person interview scheduled

September 19, 2014 Interviewed Mr. Staehelin for approximately an hour at 15:00 hours in Geneva, Switzerland

September 23, 2014 In-person interview scheduled with Dr. Idris Guessous via his secretariat, Ms. Catherine Zarola

September 29, 2014 Six hours of analysis and writing at the United Nations library

September 30, 2014 Emailed Dr. Paul Pharoah regarding colorectal cancer screening in Cambridge, England- no longer active in research, dead-end

September 30, 2014 Emailed Dr. Gill of NHS in England regarding screening outcomes of patients who have undergone early detection- dead-end, no response

September 30, 2014 Emailed Dr. Stuart Taylor regarding screening options in London, England- focused on staging after diagnosis and not screening, dead-end

September 30, 2014 Emailed Dr. Will Steward of Leicester, England regarding new screening options in England- email interview conducted the same day although no significant contribution to the paper

October 3, 2014 Final ISP proposal turned in for review

October 10, 2014 Second ISP advising session

October 13, 2014 Three hours of analysis and writing at the United Nations Library

October 15, 2014 Six hours of analysis and writing at the United Nations Library

October 16, 2014 Interviewed Dr. Guessous for approximately 1.5 hours at 16:00 hours in Geneva, Switzerland

October 16, 2014 Analysis of Mr. Staehelin's, Dr. Guessous, and Dr. Marbet's interviews for approximately five hours during travel time from Altdorf, Switzerland

October 17, 2014 Interviewed Dr. Marbet for approximately an hour at 16:00 hours in Altdorf, Switzerland

October 19, 2014 Six hours of analysis and writing at a local coffee shop

October 20, 2014 Emailed Ms. Clare Manning of the National Cancer Screening Services in Ireland regarding the national colorectal cancer screening program- see following day

October 20, 2014 Emailed Dr. Hong Jin Kim in the United States regarding the average cost of colorectal cancer screening services- dead-end, redirected to more appropriate people

October 21, 2014 Email interview conducted with Manning regarding challenges in starting the Irish screening program

October 21, 2014 Emailed Ms. Lucia Gomez-Garbero of Tucumán, Argentina regarding the Ministry of Health's implementation of a colorectal cancer screening program throughout Argentina in July 2014- email interview followed

October 25, 2014 Analysis of all previous interviews and literature review conducted for approximately three hours

October 27, 2014 Email interview with Ms. Gomez-Garbero regarding challenges facing the success of the colorectal cancer screening program

November 1, 2014 First draft of the ISP is completed

November 5, 2014 First edits of the ISP

November 10, 2014 Second edits of the ISP

November 18, 2014 Final edits of ISP completed and ISP formatted- 7 hours of work

November 19, 2014 ISP turned in for review

Questions prepared for advisor meetings

September 10, 2014 Met with Dr. Heikki Mattila to discuss the potential topic of colorectal cancer screening programs for my ISP topic. Questions included:

1. Is there a gap in knowledge regarding what constitutes effective colorectal cancer screening programs?
 - a. Write-up: Yes, several countries do not have national colorectal cancer screening programs in place and could benefit from potential guidelines.
2. Is there enough information available to write a research paper on? Does more data need to be collected?
 - a. Write-up: Although certain countries do not have data on the prevalence of colorectal cancer and/or screening coverage, focus on the abundant data from the UK and American Cancer Society.

October 10, 2014 Met with Dr. Alexander Lambert to discuss the role and format of interviews. Questions included:

1. My ISP related to the global context of colorectal cancer screening programs, how do I conduct in-person interviews of people in different countries?
 - a. Write-up: You do not conduct in-person interviews, unfortunately (at this point I focused on Switzerland as a case study within my ISP since the three formal interviews could only be in Switzerland).
2. Are Skype interviews considered informal?
 - a. Write-up: Yes, they are informal.
3. What should I do if I do not receive a response to my emails?
 - a. Write-up: Call them within three days to follow-up.

Interview Questions

Julien Staehelin

1. Which hospitals are covered under health insurance in the canton of Vaud? Which have colorectal screening centers in them?
2. If someone has a family history or personal history of colorectal cancer, does his/her health insurance cover colonoscopies more than once every ten years?
3. After the age of 69, are enrollees required to pay all colorectal cancer screening costs themselves?
4. If a patient is recommended to have fecal occult blood tests (FOBTs) done annually, will health insurance cover some of the costs? Or are FOBTs strictly covered biannually?
5. Do insurance companies cover biopsies or other surgical procedures if adenomas are found?
6. If referred to an oncologist, will the basic insurance package cover “specialist” visits?
7. What role do health insurance companies play in encouraging early diagnosis of colorectal cancer, if any?
8. (This may not be applicable to you) How many colorectal screening centers are endorsed by SWICA Health Insurance? Where are they located?
9. Does SWICA endorse noninvasive screening options as alternatives (other than FOCTs) to colonoscopies?

10. How are migrants and/or refugees covered under health insurance programs in Switzerland if they cannot afford premiums? Does the canton in which they reside cover their coinsurance in screening as well?

Idris Gusseous

1. What sociodemographic factors prove influential in access to colorectal cancer screening?
2. How was the data collected and analyzed?
3. Who will fund the pilot program and when will it commence?
4. Which tests will the screening program offer?
5. How will the program cater to high-risk groups?
6. Who will provide advocacy and educational training to the general public regarding colorectal cancer?

Urs Marbet

1. How long has the pilot program been in effect?
2. What have proven the largest hindrances in implementation of the program?
3. Who initiated the program? How was the population data collected? Who fund the program?
4. Which tests will the screening program offer?
5. How will the program cater to high-risk groups?
6. Who will provide advocacy and educational training to the general public regarding colorectal cancer?

Will Steward

1. When are you planning to implement the trial/what research needs to be done before the trial commences?
2. Would they be put on curcumin only after a polyp was found or if they have a familial history?

Clare Manning

1. Since 2007, what are the largest challenges that have arisen in the implementation of BowelScreen?
2. What aspects make the program successful?
3. Through what methods are participants encouraged to enroll?

Lucia Gomez Garbero

1. Qué desafíos has visto en el inicio del programa nacional de detección?
2. Qué es la población objetivo para el programa?
3. Qué tipos de exámenes tu ofreces a la población por tu programa (e.g. FOBTs, FITs, colonoscopias)?
4. Quién financia el programa?
5. Hay estigma sobre pruebas de cáncer?

Interview Write-Ups

Julien Staehelin

Very informative regarding insurance coverage of colorectal cancer screening services and the role of the national Swiss government in dictating what is considered treatment of cancer vs. preventative care.

Idris Gusseous

Expert regarding demographic data considered in forming the canton-based colorectal cancer screening program in Vaud, Switzerland. Spoke about the recent phone survey used to determine which demographic factors have a significant impact on the prevalence of colorectal cancer and/or cancer screening.

Urs Marbet

Expert interviewed to gain more information on the first established canton-based colorectal cancer screening program in Switzerland, in Uri. He is a leading member of the program and initiated the establishment. He is not only an advocate but also a medical doctor who conducts colonoscopies and prescribes FOBTs.

Will Steward

Email interview regarding clinical trials to provide more screening options for colorectal cancer. If approved, these trials could provide more effective and inexpensive options for screening programs to offer the population.

Clare Manning

Advocate on the behalf of the National Cancer Screening Services in Ireland.
Answered my questions regarding challenges the colorectal cancer program has faced in the first ten years of its implementation.

Lucia Gomez Garbero

Leading factor in the implementation of a national colorectal cancer screening program in Tucumán, Argentina through the Ministry of Health. Answered my questions regarding the challenges the program has faced in the first months of its implementation.

Research locations

United Nations Library

Palais des Nations, 1211 Genève

Human Resource List

Contact name	Title	Place of Employment	Phone	Address	Area of expertise	Type of Interview
Julien Staehelin	Insurance broker	SWICA Assurance	021 619 49 00	Boulevard de Grancy 39 1006 Lausanne	Health insurance	Formal
Idris Gusseous	<i>Médecin Adjoint</i>	Hôpitaux Universitaires de Genève	+ 41 22 305 58 61	4, Rue Gabrielle-Perret-Gentil 1211 Genève 14, Suisse	Colorectal cancer	Formal
Urs Marbet	Mitglied der Fachkommission Darmkrebs der Nationalen Krebsbekämpfungsprogramme der Krebsliga	Kantonsspital Uri	041 875 51 32	Kantonsspital Uri, Spitalstrasse 1, 6460 Altdorf UR	Colorectal cancer	Formal
Will Steward	Professor	University of Leicester	+ 44 (0) 116 258 7597	Osborne Building, Leicester Royal Infirmary, LE1 5WW, UK	Colorectal cancer	Informal
Clare Manning	Communications Executive	National Cancer Screening Service	+353 1 865 9300	King's Inns House, 200 Parnell St, Dublin 1, Ireland	Colorectal cancer	Interactive research

Lucia Gomez-Garbero	Program assistant	Ministry of Health	N/A	Edificio MSP, Tucumán 2174 Piso 1. Posadas	Colorectal cancer	Interactive research
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