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Recognizing Diagnostic Gap in Colorectal Cancer

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Abstract

Background: Colorectal Cancer (CRC) is the third most common type of cancer in the United States. As such, it is a significant cause of morbidity and mortality. The goal of this article is to make an attempt at identifying the number of unscreened individuals that are currently harvesting CRC for future presentation.

Methods: The total US population from the years 2003-2012 was obtained from the US Census Bureau. The percentage of population screened over time of interest was obtained from NCQA. The incidence of CRC via flexible sigmoidoscopy is 1.29% in the screened group and 1.64% in the unscreened group, with a relative risk of 0.79. The number needed to screen (NNS) to avert one CRC diagnosis and one CRC related death is 278 and 850, respectively.

Results: Increased screening has decreased the Diagnostic Gap (DG). In 2003, 62.3% of the total expected new CRC cases were being attributed to the DG. In 2012, this number has reduced to 43.1%. In other words, of the total 1,210,677.10 cases of CRC diagnosed from 2003-2012, 521,344.13 cases were from the DG by 2012. Of these cases, 21.9% or 114,349.91 cases could've been averted if 100% of the population underwent screening by 2012.

Conclusion: Acknowledging the DG will be the first step in making ACRC an entity of the past.

Keywords: Diagnostic Gap; Colorectal Cancer; Flexible Sigmoidoscopy; Screening

Introduction

Colorectal Cancer (CRC) is the third most common type of cancer in the United States [1,2]. As such, it is a significant cause of morbidity and mortality. The published literature, thus far, has devoted most of its time and effort in documenting the efficacy of our current screening programs.

However, less than 70% of the at-risk population has been screened [3]. The numbers of CRC originating from the unscreened population remain widely unrecognized.

The average-risk of the unscreened population for CRC has the potential to make a considerable impact on our current healthcare system, especially when taking into account the slow developing disease process.

The sequence of adenoma to carcinoma has been well described by Dr. Vogelstein in the 1980's and has recently been further characterized by Dr. Strum [4].

It is well established that the transition from an adenoma to adenocarcinoma may take years to manifest itself [4-6].

Therefore, in the unscreened population, we have an undiagnosed group of people with early CRC that is being harvested; only to later present itself as advanced CRC (ACRC). This highlights the concept of Diagnostic Gap (DG).

DG is defined as the incidence of CRC in the unscreened population that we fail to identify in its early stages due to lack of compliance with screening as recommended by multi-society task force.

These individuals have an overall poorer prognosis due to a delayed presentation and stage of diagnosis. As per SEER database, the 5-year survival percentage for individuals diagnosed at a localized stage is higher when compared to those diagnosed at an advanced stage - 90.1% vs. 13.1% [7].

The overall 5-year survival rate for CRC regardless of the stage at diagnosis is 64.9%. Increasing the percent of population screened will not only lead to a decreased mortality but also reduce the number of CRC diagnosed by identification and treatment of precursor lesions.

This, in turn, will lead to a decrease in the financial burden attributed to CRC. However, to accomplish this goal, one must first recognize the magnitude of the problem.

The goal of this article is to make an attempt at identifying the number of unscreened individuals that are currently harvesting CRC for future presentation.

Methods

In order to estimate the DG, several population statistics were required.

Total US population and target population

The total US population from the years 2003-2012 was obtained from the US Census Bureau [8]. This data was further divided by age group of interest (specifically 50-74.99 years) and gender [8]. The age of 74.99 years was rounded to 75 years.

Incidence and Death rates of CRC

The incidence and death related to CRC per 100,000 for the US population was obtained from Surveillance, Epidemiology, and End Result (SEER) database [9]. The gender adjusted statistics pertaining to the incidence and death was obtained from US Cancer Statistics [10].

Percentage of population screened

The percentage of population screened over time of interest was obtained from National Committee for Quality Assurance (NCQA) [11]. Screening in NCQA data is defined as an individual undergoing annual Fecal Occult Blood Test (FOBT), flexible sigmoidoscopy every 5 years, barium enema every 5 years, or colonoscopy every 10 years between the ages of 50-80 years from 2003-2008.

From 2009-2012, NCQA defined CRC screening as an individual between the ages of 50-75 years undergoing screening by annual FOBT, flexible sigmoidoscopy every 5 years, and colonoscopy every 10 years.

For the purposes of this report, the screening percentages of individuals between the ages of 50-75 years for the years 2003-2008 were calculated. Furthermore, NCQA reports screening in commercial and Medicare percentages separately [12].

For this report, we simply took an average of the two reported percentages to come up with a cumulative percentage. Additionally, only HMO percentages were included in reporting the overall screening.

Cost of initial and final year of CRC

The cost of initial and final year of CRC diagnosis was calculated in dollars based on Yabroff's estimates as reported in 2002. The cost of first year of diagnosis was estimated at $35,976 for males and $36,576 for females [13,14]. The cost of final year of diagnosis was estimated at $51,012 for males and $51,492 for females [13,14].

Diagnostic Gap (DG)

DG is the incidence of CRC in the unscreened group via flexible sigmoidoscopy. This was calculated by combining the incidence rates as reported in a meta-analysis of randomized controlled trials [15]. The article included five studies in the meta-analysis. However, the study conducted in Norway in 2009 was an outlier, creating "statistical heterogeneity" [15]. Therefore, this study was excluded in the calculations of incidence.

The other four studies were included. As per Elmunzer et al., 1,012 and 1,287 cases of CRC were identified in the screening arm (N=77,445) and the control arm (N=77,455), respectively [15]. As per Segnan et al., 251 and 306 cases of CRC were diagnosed in the screening arm (N=17,148) and control arm (N=17,144), respectively [16].

As per Atkin et al., 706 and 1,818 cases of CRC were noted in the screening arm (N=57,237) and control arm (N=113,195), respectively [17].

As per Thiis-Evensen et al., 2 and 10 cases of CRC were observed in the screening arm (N=399) and control arm (N=400), respectively [18]. Combining the data from four studies translates into 1,971 cases of CRC in the screening arm (N=152,229) and 3,421 cases of CRC in the control arm (N=208,194).

Therefore, the incidence of CRC via flexible sigmoidoscopy is 1.29% in the screened group and 1.64% in the unscreened group, with a relative risk of 0.79 (Table 1).

	Elmunzer et al. [15]	Segnan et al. [16]	Atkin et al. [17]	Thiis-Evensen et al. [18]	
# CRC screening arm	1,012	251	706	2	1,971
# CRC control arm	1,287	306	1,818	10	3,421
N in screening arm	77,445	17,148	57,237	399	152,229
N in control arm	77,455	17,144	113,195	400	208,194
Incidence in screened = 1,971152,229 = 0.0129; Incidence in the control arm = 3,421208,194 = 0.0164; Relative risk = 0.01290.0164 = 0.79					

Table 1: The incidence of CRC via flexible sigmoidoscopy in the screened group and the unscreened group.

Averted CRC diagnosis and death

The number needed to screen to avert one CRC diagnosis and one CRC related death is 278 and 850, respectively [15].

Results

From 2003 to 2012, the percentage of population compliant with screening has steadily increased from 43.5% to 62.7% in the age group of 50-75 years (Figure 1). Consequently, the percentage of unscreened population has decreased from 56.5% to 37.3% (Figure 2).

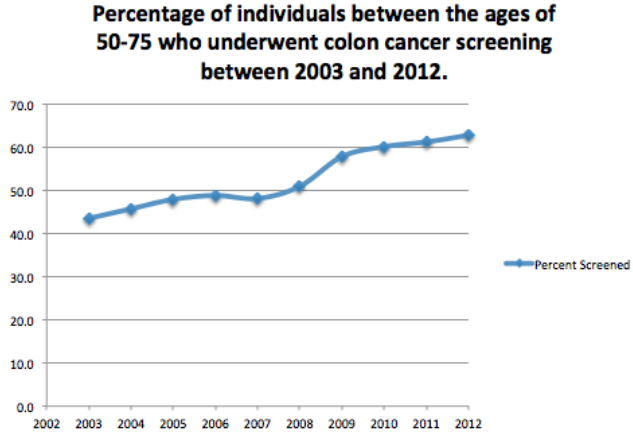

Figure 1: Percentage of individual's between the age of 50-75 who underwent colon cancer screening between 2003 and 2012.

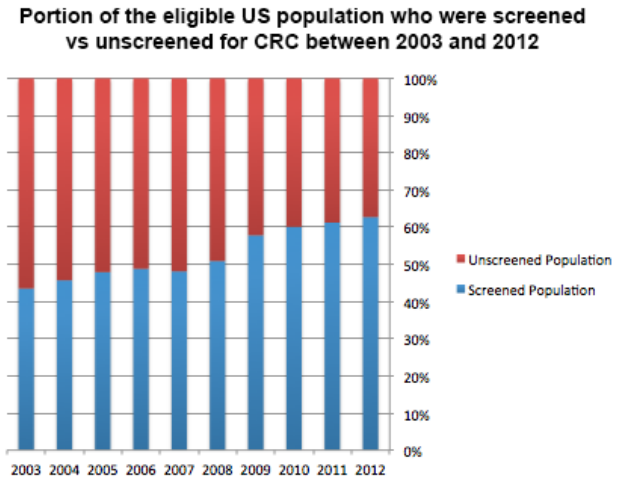

Figure 2: Portion of the eligible US population who were screened vs unscreened for CRC between 2003 and 2012.

During the same time frame, the aging population has been rising from 23.3% to 27.9%, an increase of 20 million people. Accounting for this increase, the at-risk population equals to 85,225,941 over a decade (Table 2).

Year	Total USA Population	Total USA pop 50-74.99 years
2012	314,112,078	85,225,941.00
2011	311,721,632	83,166,512.00
2010	309,347,057	80,996,963.00
2009	307,006,550	77,340,407.00
2008	304,374,846	75,193,592.00
2007	301,579,895	73,019,421.00
2006	298,593,212	70,852,898.00
2005	295,753,151	68,901,661.00
2004	293,045,739	66,981,726.00
2003	290,809,777	65,190,317.00

Table 2: The total USA population and "average risk" population for CRC from 2003 to 2012.

The incidence of CRC via flexible sigmoidoscopy in the screened population is 1.29% and 1.64% in the unscreened population.

Assuming that no one from the target population was screened in 10 years, we would've diagnosed a total of 1,397,705.43 new cases of CRC.

However, based on current trends of screening, a total of 192,218.22 cases of CRC have been averted from 2003-2012. This reduced the overall number of newly diagnosed CRC to 1,210,677.10 in the same time frame (Figure 3).

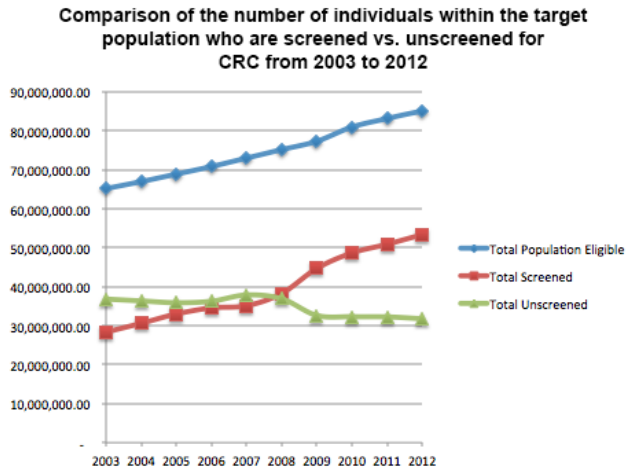

Figure 3: Comparison of the number of individuals within the target population who are screened vs unscreened for CRC from 2003 and 2012.

Over a decade, increased screening has decreased the DG, which is the number of new CRC diagnosed from the unscreened population. In 2003, 62.3% of the total expected new CRC cases were being attributed to the DG. In 2012, this number has reduced to 43.1% (Table 3). In other words, of the total 1,210,677.10 cases of CRC diagnosed from 2003-2012, 521,344.13 cases were from the DG by 2012. Of these cases, 21.9% or 114,349.91 cases could've been averted if 100% of the population underwent screening by 2012. Similar trends are noted for CRC related death. In 2012, 37.3% of the target population still remained unscreened. This translates into an excess of 37,399.15 CRC related deaths that could've been prevented.

Year	Percentage of CRC attributed to the DG over time	Number of CRC attributed to the DG over time
2012	43.1%	521,344
2011	44.6%	529,205
2010	45.8%	530,012
2009	48.1%	535,257
2008	55.1%	605,489
2007	57.8%	621,512
2006	57.2%	594,938
2005	58.0%	588,723
2004	60.2%	596,486
2003	62.3%	604,053

Table 3: Change in DG based on improved adherence to screening guidelines.

Excess CRC diagnoses and CRC related deaths have led to increased expenditure that may have been prevented. Over the last 10 years, 114,349.91 cases of CRC could've been prevented with timely screening

of the unscreened population. Based on available trends from the CDC, men are 1.28 times as likely as women to be diagnosed with CRC. Therefore, of the 114,349.91 cases that would've been prevented, 64,035.95 cases would've been males and 50,313.96 would've been females. This translates into a savings of $2,303,757,396.22 in males and $1,840,283,474.23 in females from 2003-2012. Over the same time frame, a total of 37,399.15 lives could've been saved from CRC. According to CDC, males are 1.04 times as likely as females to die from CRC. Therefore, of the 37,399.15 cases of CRC related mortality, 19,073.57 were expected to be males and 18,325.58 were females. This translates into $972,980,728.17 spend in excess on CRC related mortality in males and $943,620,900.85 in females.

Discussion

Over the past few years, increased advocacy for CRC has led to an increase in adherence to the recommended screening guidelines. While this shows a significant improvement in our screening efforts over a decade, it is simply not enough when taking into account the steady rate of increase in the aging population with each passing year. In 2003, our unscreened population equaled 36,832,529.11. In 2012, this number decreased to 32,637,651.75, a mere change of 4,194,877.36 people in a decade (Table 4).

Year	Total Number of individuals screened, aged 50-75 years	Total Number of individuals unscreened, aged 50-75 years
2012	53,436,665.01	31,789,275.99
2011	50,897,905.34	32,268,606.66
2010	48,679,174.76	32,317,788.24
2009	44,702,755.25	32,637,651.75
2008	38,273,538.33	36,920,053.67
2007	35,122,341.50	37,897,079.50
2006	34,576,214.22	36,276,683.78
2005	33,003,895.62	35,897,765.38
2004	30,610,648.78	36,371,077.22
2003	28,357,787.90	36,832,529.11

Table 4: The total number of individuals screened vs. unscreened for CRC from 2003 to 2012.

The unscreened population has the potential to make a considerable impact on our healthcare system as it includes persons who are harvesting early stages of CRC for a delayed presentation. This group represents the DG. The term "Diagnostic Gap" is a concept that hasn't been previously described with regards to CRC. This paper seeks to acknowledge the DG in efforts to eradicate advanced CRC in the near future by tailoring the current screening programs.

In order to estimate the DG, we calculated the incidence of CRC in the unscreened population based on the results of the meta-analysis [15]. Over the past decade, the total number of new CRC attributed to the unscreened population has decreased from 62.3% to 43.1%. While this notes a significant decrease, our current efforts leave something to be desired. This is predominantly because, of the 43.1% of CRC cases originating from the DG, 21.9% of the cases could've been averted through timely screening as recommended by the multi-society task force.

According to Seeff et al., approximately 70.1 million persons constituted the target population in the United States in 2001 [19]. Of that total, 28.3 million (40.4%) actually underwent screening, while the remaining 41.8 million people (59.6%) did not [19]. While the unscreened population has reduced overtime, 27.7% of people ages 50-75 years still remained unscreened in 2012 according to CDC's Behavioral Risk Factor Surveillance System Data [3].

The inability to achieve 100% screening rates over time has translated into increased CRC diagnoses, mortality, and costs. As per Meester R et al., "increasing CRC screening rates to 80% by 2018 would reduce CRC incidence rate by 17% and mortality rate by 19% during short-term follow up and by 22% and 33%, respectively, during extended follow up" [20]. This translates into 277,000 averted new CRC diagnoses along with 203,000 averted CRC deaths from the years of 2013 to 2030 [20]. As per Warren et al., medicare paid an average of $41,134 per person in initial cost of colorectal cancer care in 2002 [13]. This translated into an estimated $2,038,244,271 spent in medicare dollars for the care of 49,551 patients diagnosed in 2002 [20]. Of the $2 billion spent, 53.1% was attributed to cancer related surgeries, 9.2% to chemotherapy, 0.9% to radiation therapy, and 18.4% to other hospitalizations [13].

Our study estimates similar CRC related expenditures. From 2003-2012, we've spent $6,060,642,499.48 in excess in the first and final year of CRC diagnosis due to non-adherence to current screening guidelines. However, this figure is an underestimation as it is reported in 2002 dollars. This estimate does not take into account the rate of inflation over a decade, the cost of CRC care through an individual's lifetime (whose diagnosis would've been otherwise prevented through timely screening), or the stage of diagnosis. Unscreened persons, by definition, harbor CRC for a delayed presentation. This, in turn, increases the cost of CRC diagnosis. According to Taplin et al., the initial cost of care if colon cancer is diagnosed at carcinoma in situ is $7002 vs. $11,624 at the local stage, $13,367 at the regional stage, and $15,276 at a distant stage (in 1992 dollars) [21].

While the study talks about averted CRC diagnoses and mortality by timely screening with flexible sigmoidoscopy, it does not seek to propose that this screening modality be implemented for each individual in the target population. Rather, the goal of this study is to estimate and recognize the DG. Recognizing the DG allows us to identify individuals harvesting ACRC. This, in turn, could guide our efforts in improving our current screening methods to achieve close to 100% adherence by the population of interest.

If the rate of CRC screening continues at our current trends, we will continue to increase the financial burden on our healthcare system through diagnosing preventable CRC. Therefore, it is vital to recognize the magnitude of the problem. Acknowledging the DG will be the first step in making ACRC an entity of the past.

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