Computed tomographic colonography vs. optical colonoscopy: essentials for colorectal cancer screening in the asymptomatic patient

Joshua Scott Daniel Colliver
The University of Toledo

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Essentials for colorectal cancer screening in the asymptomatic patient

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2011
Dedication

I dedicate my scholarly project to families, friends, and those who have been affected by colorectal cancer, that we may reach a point in society where colorectal cancer no longer negatively affects the number of people it does today. This is also dedicated to my family who has stood behind me with each decision I’ve made in my life.
Acknowledgement

Many thanks to Dr. Amanda Bryant-Friedrich for guidance and support throughout this process. Her expertise has allowed me to challenge myself and grow not only as a student, but also as an individual.
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**Introduction**

Colorectal cancer (CA) is associated with high morbidity and mortality rates. It is still the second leading cause of death related to cancer in the United States (American Cancer Society, 2008). Approximately 150,000 new cases are reported each year with about 1/3 of these cases resulting in mortality (Lansdorp-Vogelaar, van Ballegooijen, Zauber, Habbema, & Kuipers, 2009). One step towards reduction in the number of new cases annually is to get more patients to have routine screenings performed when existing guidelines make them eligible. Screening guidelines, as set by the American Cancer Society, are as follows: Asymptomatic males and females are recommended to have either a fecal occult blood test (FOBT) annually, flexible sigmoidoscopy + FOBT every 5 years, colonoscopy every 10 years, flexible sigmoidoscopy every 5 years, or double contrast barium enema (DCBE) every 5 years starting at the age of 50 years old (Smith et al., 2002). Guidelines change for patients that are symptomatic or have risk factors for CA. This paper focuses on asymptomatic patients undergoing routine screening.

Research shows that 50-60% of people greater than 50 years of age do not undergo routine screening for colorectal CA (Philip, Lubner, & Harms, 2011). It is not known as to why this number is so high. An intervening factor to help lower this number could be the utilization of mid-level providers. Mid-level providers, such as nurse practitioners and physician assistants, often spend more time with patients allowing for additional patient education. Educating patients on the importance of screening is a necessity to prevent colorectal CA. Patients tend to place more trust in mid-level providers and feel more comfortable with their recommendations due to the fact that they spend time with and listen to them. Health care providers that recommend patients undergo colorectal CA screening often do so by referring them for a
colonoscopy. A survey done in 2006-2007 by Klabunde et al showed that the screening method of choice recommended to asymptomatic patients by their provider was colonoscopy 95% of the time versus only 5% recommending CT colonography (Klabunde et al., 2009). It is often predicted that patients do not want to undergo a screening examination that is invasive, costly, and time consuming. Colonoscopy is a method where a flexible endoscope is inserted into the rectum and allows for visualization of the lumen of the colon through a video monitor. Colonoscopy requires that the patient undergo a bowel cleansing preparation the day before the procedure. On the day of the procedure, the patient is necessarily sedated for the procedure to be accurately performed (Philip et al., 2011). In contrast to this, a newer method of colorectal CA screening, called computed tomographic colonography (CT colonography) is slowly gaining acceptance as a viable option for patient screening.

CT colonography is a minimally invasive test that allows the detection of colorectal polyps using 2-dimensional (2D) and 3-dimensional (3D) views of the colon. CT colonography uses radiation that in turn creates an image of the lumen of the colon on a monitor. The images are presented in either a 2D or 3D fashion. The patient undergoes a CT scan in the supine and prone position. This allows for the displacement of stool or retained fluids during the procedure. Just like a standard CT scan, images are obtained according to slice thickness and the number of slices determined for adequate results (Pickhardt, Hassan, Halligan, & Marmo, 2011). CT colonography focuses on four important parameters to produce a successful study. These are colon preparation, colonic distension, CT equipment and operation, and study interpretation (Philip et al., 2011). Colon preparation is the start point to conducting a successful study. It has been shown that adding a cathartic and tagging agent to the bowel preparation results in higher sensitivity for polyp detection (Pickhardt et al., 2011). The nature of the preparation used is
ultimately up to the physician or healthcare provider administering the test (Macari et al., 2011). Cathartic agents are important due to the fact that they help empty the bowel insuring that no residual stool is left. Fecal tagging agents can also be used to bind residual stool and not allow for it to show up on the scan. Without a cathartic or fecal tagging agent, residual stool could erroneously show up as a polyp. Colon distension allows for the colonic mucosa to be better visualized during the scan. This is usually achieved by introduction of room air or carbon dioxide (CO₂). The use of CO₂ has been linked to lower perforation rates due to the fact that it has a faster resorption rate than air (Philip et al., 2011). In addition, CO₂ does not cause the patient significant gas retention, as does room air, allowing for increased comfort post scan. CT equipment is designed to detect polyps with a standard minimum size of 6 mm. Study interpretation is key to the use of a diagnostic technique such as CT colonography. It is recommended that when reading CT colonography the reader start by looking at the 3D scan and then use the 2D scan for confirmation of findings (Philip et al., 2011).

CT colonography has pros and cons associated with its use. On the negative side, as with optical colonoscopy, the patient has to undergo bowel preparation the day before the procedure. Some other cons to CT colonography are patient exposure to radiation during screening. If a polyp is found on CT colonography, a follow up examination is performed using optical colonoscopy. Since the patient is being examined by a CT scanner, other areas of the body may also be visualized. With this said, an area of concern is the detection of extra colonic processes and how this information should be handled.

As for the benefits of CT colonography, the technique is minimally invasive, less time consuming, and carries a lower risk of colon perforation (Heiken, 2003). Studies show that the
sensitivity and specificity of CT colonography is beginning to match that of optical colonoscopy.

CT colonography has a bright future in the initial screening phase of colorectal CA.
Availability of CT Colonography in U.S. Hospitals

A major limitation regarding the use of CT colonography is finding an institution or practice that offers it. As of 2008, only 17% of all general hospitals that were not federally funded offered CT colonography at their respective institutions. Although this is not a breathtaking percentage, there has been a statistically significant increase (p<0.05) in the number of hospitals offering CT colonography since 2005. These hospitals were large hospitals, hospitals located in the Northeast, teaching hospitals, private non-profit hospitals, and non-rural hospitals (Skinner, & Staiger, 2009). One factor that has been discussed in the literature is whether or not hospitals offering CT colonography also offer optical colonoscopy. A 2008 study revealed that 69% of the hospitals offering CT colonography also offered optical colonoscopy (McHugh, Osei-Anto, Klabunde, & Galen, 2011). Optical colonoscopy is a necessity for an institute that offers CT colonography. In the event that a polyp is found it can be removed the same day. The patient will already have completed bowel preparation and therefore could undergo the optical colonoscopy without having to repeat preparation.

Availability of CT colonography needs to expand in order for practitioners to be able to offer this imaging modality as a first line screening technique for asymptomatic adults greater than 50 years of age. A study done by McHugh et al in 2010 that looked at adoption of CT colonography by U.S. hospitals showed several major factors that led to the increased availability of CT colonography across the country. Surveys were sent to all CEO’s of hospitals in the country who then directed them to the right department to address the study. Among the surveys completed, the following answers were given for factors that led to the adoption of CT colonography at their institutions: alternative screening option for elderly adults or patients who failed optical colonoscopy (inability of endoscope to reach cecum), low colorectal cancer
screening rates in the community, and interests shown by either radiologists or gastroenterologists at the institution (McHugh et al, 2011). For CT colonography to become a viable screening option, multiple factors need to be in place. This is not going to be a decision made by one person or one department; it needs to be initiated by a multidisciplinary approach.
Cost-effectiveness

For a test to prove valuable in screening patients for any kind of disease, it has to be cost-effective. When thinking about cost-effectiveness, the issue can be viewed from a couple of different angles. The first and most obvious one is the actual cost of the test. If a test is tremendously expensive compared to other already available tests, it will not likely be cost-effective. Another angle compares the cost of the test to the cost of treating the disease the test screens for. Ultimately, weighing both angles will give you the best view of cost-effectiveness. Cost-effectiveness will be a major factor in the determination of whether CT colonography is an ideal screening method for asymptomatic patients in regards to colorectal CA.

To take a deeper look into this, the Markov state-transition model based on the natural history of colorectal CA was reviewed. This model tracks development of growth of adenomas from the time it becomes malignant. This model is based on the fact that screening begins in patients at the age of 50 and continues up to age 80 (Vijan, Hwang, Hofer, & Hayward, 2001). To determine cost-effectiveness, characteristics including adenoma size were used as parameters to determine sensitivity. The sensitivity rate was then used to determine cost-effectiveness. Since Medicare does not include CT colonography as a reimbursable test, the reimbursement rate was based on an abdominal or pelvic CT scan (Department of Health and Human Services, Centers for Medicare and Medicaid services, 2003).

The results of the study were based on CT colonography versus no screening. In CT colonography versus a no screening group, 3D CT colonography done every 5 years proved to be more cost-effective than every 10 years. It reduced the cancer risk to 1.3% and mortality to 0.4%. This is compared with no screening with a cancer risk of 5.6% and a mortality rate of 2.1%. CT colonography was reported to have a cost-effectiveness of $13,460 per life based on a
CT colonography cost of less than $400 per test. If sensitivity is lower than 83%, optical colonoscopy would be a better option (Vijan et al., 2007). Three dimensional CT colonography done every 5 years proved to be cost-effective compared with no screening.
Bowel Preparation

To perform effective CT colonography, with high specificity and sensitivity, it is necessary to have adequate bowel preparation. Each institution has a protocol as to how they want their patients to prepare for the scan. An area of debate has arisen as to which cathartic agent is more effective. These cathartic and fecal tagging agents bind residual stool and fluid and ensure that neither shows up on the CT colonography. When residual feces are not bound this matter may show up as a pseudo polyp and may also take away from the view of the colon wall (Pickhardt, 2007).

The two major agents used for catharsis are sodium phosphate and magnesium citrate solutions. Differences between the two agents have been established in regards to physiological changes to the body. Sodium phosphate has been shown to cause hyperphosphatemic and hypocalcemic effects in patients with cardiac and renal disease. Acute phosphate nephropathy has also been noted (Markowitz, Stokes, Radhakrishnan, & D’Agati, 2005). Magnesium citrate has demonstrated safer electrolyte chemistries and is the recommended cathartic agent in patients with suspected renal or cardiac insufficiency or with patients greater than 70 years old with hypertension (Borden et al., 2010).

A study performed by Borden et al was reviewed to take a deeper look into the use of these two cathartic agents, as they relate to bowel preparation for CT colonography. The study used 118 patients who received sodium phosphate and 115 patients who received magnesium citrate. Patients were chosen from a database showing that they had under gone CT colonography for cancer screening. Bowel preparation was the same in all the patients with the exception of the cathartic agent used. Patients receiving sodium phosphate [2.4 grams monobasic, 0.9 grams dibasic per 5 ml] were given a single dose of 45 ml. The patients
receiving magnesium citrate [1.75 grams per 30 ml] were given a double dose of 296 ml separated by 3 hours. The first dose was given 3-6 hours before receiving a bisacodyl tablet (5 mg) which is used as a part of standard bowel preparation. Bisacodyl is a stimulant laxative that helps ensure the colon is clear for the study (Borden et al., 2010).

Results were determined based on stool and fluid scores. These scores indicate the size of the stool present and the amount of fluid present. Stool and fluid scores are then used to determine whether there is a statistically significant difference between the two cathartic agents. Six areas of the colon were examined to determine the scores. The six areas were as follows: ceacum, ascending, transverse, descending, sigmoid, and rectum. The stool score showed no statistically significant difference between the two agents. The sodium phosphate group showed 88.6 % having no residual stool and the magnesium citrate group had 88.1% with no residual stool (Borden et al., 2010). The fluid score showed only a statistically significant difference in the sigmoid colon with a P-value of 0.01. This showed that magnesium citrate tended to cause more fluid retention in the sigmoid colon. Ultimately this indicates no difference between the two agents (Borden et al., 2010).

One area of significant focus was residual fluid attenuation. Magnesium citrate showed lower residual attenuation rates as compared with sodium phosphate. The lower attenuation rate was shown to correspond with an increase in polyp conspicuity upon CT colonography (Borden et al., 2010). This should lead to increased sensitivity and specificity. Based on these studies, both agents are efficacious in their cathartic ability. With this being the case, magnesium citrate can be the cathartic agent of choice since it has a higher therapeutic index and an increase in polyp conspicuity (Borden et al., 2010).
Efficacy of CT Colonography

The most important factors in the validation of a screening test are efficacy, sensitivity and specificity. It will be necessary that CT colonography offer sensitivity and specificity very similar to that of conventional colonoscopy for institutions and practitioners to adopt it for use. A systemic review and meta analysis conducted by Pickhardt et al. in May 2011 looked at several studies conducted by various researchers across the country. Several of the studies included, looked at CT colonography as a screening method in asymptomatic patients.

Pickhardt et al conducted a study in 2003 that enrolled 1253 asymptomatic patients ages 50 to 79. The studies were done at 3 different medical centers. The patients underwent CT colonography and optical colonoscopy on the same day. Patients with a positive guaiac stool test within 6 months, iron deficiency anemia within 6 months, rectal bleeding or hematochezia within 12 months, unintentional weight loss of 10 pounds within 12 months, optical colonoscopy within 10 years, barium enema within 5 years, pregnancy, inability to undergo optical colonoscopy, inflammatory bowel disease, colorectal cancer, adenomatous polyps, familial adenomatous polyposis, hereditary nonpolyposis cancer syndromes, or inability to ingest sodium phosphate were excluded from the study (Pickhardt et al., 2003). Cathartic preparation and fecal tagging were used. A multidetector CT scanner was used with no intravenous contrast material administered. Patients were placed in both the prone and supine position and a 3D fly through mode of imaging followed by a 2D view was used (Pickhardt et al., 2011).

Lesions of interest for this study were ones of \( \geq 6 \) mm and advanced neoplasia was defined as any adenoma measuring \( \geq 10 \) mm. The colonoscopists for this study were unaware that the patients had previously undergone CT colonography. Once completed, results of the CT colonography were revealed and if a polyp of \( \geq 5 \) mm was found using CT colonography but not
identified using optical colonoscopy, the segment would be closely re-examined. This allows for re-evaluation of false negatives on optical colonoscopy and false positives on CT colonography (Pickhardt et al., 2003). Sensitivity and specificity were defined using a polyp-matching algorithm. A true positive was one in which CT colonography and optical colonoscopy found a lesion in the same area of the colon with the same diameter. For polyps ≥ 8 mm, the sensitivity of CT colonography was higher than that of optical colonoscopy, but it was not statistically significant (p = 0.31 to 0.56). The overall sensitivity according to the patient ranged from 0.929 to 0.949 and specificity was 0.910 to 0.938. Of the 1233 patients, 611 had no polyps detected using either screening modality. Among the rest of the patients, 554 adenomatous polyps were found with 2 of them being malignant based on histology. The sensitivity of CT colonography for advanced neoplasias was 0.915 versus the initial sensitivity of optical colonoscopy being 0.881. There were 756 nonadenomatous polyps detected (Pickhardt et al., 2003). Nonadenomatous polyps are classified as hyperplastic and do not have malignant capability (Li, & Burgart, 2007).

In summary, this study pointed out that CT colonography does show promise for future use as a screening option for patients. Nearly 50% of patients who were enrolled had no polyps detected and therefore did not require follow up colonoscopy. No polyps being found is the goal of screening in the asymptomatic population. Lesions measuring ≥ 8 mm had sensitivities competitive with that of optical colonoscopy. Lesions ≤ 6 mm are below the level of accurate detection using this technique.

Vogt et al. conducted a study in 2004 that looked at the sensitivity and specificity of ultra-low-dose multi slice CT colonography vs. high-resolution video colonoscopy. For this study, the dose of radiation for men was 0.75 mSv and for women was 1.25 mSv (normal dose ~
There were 115 patients enrolled in the study. The patients were all given a cathartic preparation, but no fecal tagging was used. A multi-slice CT scanner was used. No intravenous contrast was given and only supine images were taken using a 2D mode (Pickhardt et al., 2011). The exclusion criterion utilized was a first degree relative with colorectal cancer or a history of a polyp or tumor in the colon. Patients were examined using ultra-low-dose CT colonography followed by high-resolution video colonoscopy. Colonoscopists were unaware that the patients had received CT colonography prior to the colonoscopy. If a polyp was detected, a polypectomy was done and the sample sent for histopathology (Vogt et al., 2004). The ultra-low-dose scanner was used to determine if sensitivity and specificity were equal using a machine that delivers the lowest dose possible of radiation yet shows efficacy similar to that of standard dose scanners.

Lesions that were found were separated into small (<5mm), medium (5-10mm), and large (>10mm). Reference standards were based on high resolution video colonoscopy and histopathology of the detected lesions. Readers were then shown the results of the CT colonography, and then repeated the colonoscopy. There were four classifications used to categorize the lesions: tumor, polyp, flat lesion, and residual stool. The residual stool classification was added due to the absence of fecal tagging in the study design (Vogt et al., 2004). Here, only polyp efficacy will be discussed. One hundred fifty lesions in total were detected. The sensitivity and specificity were defined by a true positive which was a lesion found in the same area and of the same size with ultra-low-dose CT colonography and high resolution video colonoscopy. With ultra-low-dose CT colonography, the sensitivity for small, medium, and large polyps was 0.76, 0.91, and 1.00, respectively. The specificity for the same polyps was 0.75, 0.83, and 0.82, respectively. One hundred and forty seven of the lesions found...
were sent for histology. Ultra-low-dose multi slice CT colonography picked up 34/36 adenomatous lesions > 5mm with a sensitivity of 0.95 and specificity of 0.92. The sensitivity and specificity of high resolution video colonoscopy of the same sized lesions was 0.93 and 0.90 (Vogt et al., 2004).

In summary, ultra-low-dose multi slice CT colonography shows promise for use as a screening option for asymptomatic patients over standard dose CT colonography and high resolution video colonoscopy. The sensitivity and specificity for adenomatous lesions ≥ 8 mm approaches that of traditional testing. Work still needs to be done in the area of smaller lesions. This study did not use fecal tagging which has been shown to improve the overall accuracy of CT colonography.

A study performed by Johnson et al. in 2007 looked at primary 2D versus 3D 360 degree virtual dissection modes of imaging for the detection of colorectal lesions in asymptomatic patients using CT colonography. The 3D 360 degree virtual dissection is a new technique that opens the bowel at the midline like a surgical specimen (Rottgen et al., 2005). There were 452 patients enrolled in the study. Subjects were excluded from the study if any of the following conditions existed: melena, hematochezia, inflammatory bowel disease, and familial polyposis (Johnson et al., 2007). Subjects underwent CT colonography followed by same day colonoscopy. Cathartic preparation was used with no fecal tagging. A multidetector CT scanner was used. No intravenous contrast material was used and the patients were placed in the prone and supine positions. Primary 2D imaging was used compared with 3D 360 degree virtual dissection (Pickhardt et al., 2011). Reference standards were established by endoscopy. This included same day index colonoscopy and any other endoscopies done during the study period. Only adenomatous polyps were examined (Johnson et al., 2007).
A total of 93 lesions were detected with 50 being 6-9 mm and 43 being ≥ 1cm. Sixty four of the 93 lesions showed up as neoplastic in nature. The study did not find any significant differences in the ability of 2D imaging to detect lesions at 1.25 and 2.5 mm slices vs. 3D imaging at 1.25 and 2.5 mm slices as compared to optical colonoscopy (Johnson et al., 2007). When a double review was done using primary 3D and primary 2D imaging together at common slice thickness of 1.25 mm and 2.5 mm, the sensitivity of lesions ≥ 1 cm was 0.95 and 0.84, respectively. There was a sensitivity of 1.00 for adenocarcinomas ≥ 1 cm. The sensitivity of colonoscopy of lesions ≥ 1 cm was 0.77 and for adenocarcinomas ≥ 1 cm was 0.20 (Johnson et al., 2007).

In summary, there was no significant difference in slice thickness with either a 2D or 3D mode of imaging in detecting adenomas ≥ 10 mm. This was the case for per patient and per lesion sensitivity. When a double review was done using both 2D and 3D modes of imaging at 1.25 and 2.5 mm, the sensitivity was higher for both adenomas and adenocarcinomas compared to that of optical colonoscopy.

A 2008 study conducted by Johnson et al had 2600 asymptomatic patients age 50 and older enrolled. These patients were enrolled at 15 different study centers around the country. Exclusion from this study was based on patients having either melena or hematochezia on more than one occasion in the 6 months prior to the study, inflammatory bowel disease, lower abdominal pain, familial polyposis syndrome, a medical condition that put them at risk for colonoscopy, colonoscopy within 5 years of the study, anemia with a hemoglobin level of < 10, or a positive fecal occult- blood test (Johnson et al., 2008). Cathartic preparation and fecal tagging were used in this study. A multidetector CT scanner with 16 or more rows was used (45% using 16 slice, 3% using 40 slice, 52% using 64 slice). This refers to the number of
sections the CT scanner will slice the focused area into. No intravenous contrast material was
given to the patients for the study. Both prone and supine positioning were used for the scan. A
2D mode of imaging was used for the study (Pickhardt et al., 2011).

A population of 2531 patients underwent the study after exclusions were eliminated. The
participants underwent CT colonography followed by colonoscopy according to an institution
protocol. Reference standards for this study were based on the results of the colonoscopy
(second one when indicated) and pathological examinations of the tissue specimens. A lesion
detected by CT colonography was considered positive when measuring 5 mm or more. If these
lesions met the criteria of the study, > 10 mm or 6-9 mm, then the CT colonography was
considered to have detected a true positive. If a 5 mm lesion was identified but did not fit in the
range of the study criteria then it was considered a false positive (Johnson et al., 2008). The
lesions were then identified by histological review and adenomas were defined as polyps with
cytologic dysplasia involving the epithelium extending to any crypt depth (Torlakovic et al.,
2008).

The per patient sensitivities and specificities for lesions ≥ 5 mm, 6 mm, 7 mm, 8 mm, 9
mm, and 10 mm, respectively could be detected at sensitivities of 0.65, 0.78, 0.84, 0.87, and
0.90, respectively. The specificity for these same sizes was 0.89, 0.88, 0.87, 0.87, 0.86, and
0.86. There were 1322 adenomas or cancers found on CT colonography with sensitivities
determined through a lesion matching algorithm. The sensitivities for per polyp analysis were
determined for those ≥ 5 mm, 6 mm, 7 mm, 8 mm, 9 mm, and 10 mm. Sensitivities were 0.59,
0.70, 0.75, 0.80, 0.82, and 0.84, respectively. The median size of the neoplasms not detected by
CT colonography was 6 mm.
In summary, CT colonography using a 2D mode of imaging detects lesions $\geq 10$ mm in 90% of patients. Smaller polyps are not detected by CT colonography at accuracy levels that make it a viable option. This study used radiologist and endoscopists who did not have advanced training in this method, so sensitivities tended to be lower than other multicenter studies.

Another study done by Macari et al. in 2004 looked at 68 average-risk asymptomatic men and the efficacy for CT colonography in screening for polyps and cancers. Exclusion criteria included colorectal symptoms, a positive faecal occult blood test in the past, prior sigmoidoscopy or colonoscopy, familial history with a 1st degree relative with colon cancer, prior DCBE examination, or a history of colorectal polyps. Patients were placed in prone and supine positions. A multidetector CT scanner was used and 2D and 3D imaging was performed. After CT colonography was performed, patients were to follow up with a colonoscopy within one month. All specimens collected were sent for histopathology (Macari et al., 2004).

The polyps that were examined to determine efficacy were those 1-5 mm, 6-9 mm, and $\geq 10$ mm. A true positive was considered when CT colonography and optical colonoscopy depicted a lesion in the same segment of the colon, same size, and same morphology (Keegan, Goldgar, & Keahey, 2010). Ninety eight polyps were detected in total. For 1-5 mm polyps, optical colonoscopy detected 78 polyps and CT colonography detected 9. The sensitivity for detection of 1-5 mm polyps using CT colonography was 0.12. Specificity was unreported. For polyps 6-9 mm, 17 polyps were detected by optical colonoscopy and 9 were found on CT colonography. The sensitivity for this group was 0.53. Specificity was unreported. For polyps $\geq 10$ mm, optical colonoscopy picked up 3 polyps and CT colonography picked up 3 polyps. The sensitivity for this group was 1.00 and the specificity was 0.985.
In summary, CT colonography proved to provide sensitivities comparable with optical colonoscopy in lesions that were $\geq 10$ mm. No fecal tagging was used which created false positives on CT colonography lowering the sensitivity. Use of fecal tagging could increase the sensitivity in smaller lesions.
Conclusion

Key to lowering colorectal cancer from its position of the second leading cause of cancer related death is sensitive and accessible screening. We know that 50-60% of the population over the age of 50 years old will not have a routine colorectal screening, such as colonoscopy, to help prevent the development of advanced colorectal CA (Philip et al., 2011). A less invasive method performed for screening that is well on its way to becoming a first line option for this purpose is CT colonography. Various factors still remain creating obstacles to the introduction of this technique for early screening.

In the United States, CT colonography is not offered at many facilities. It is known that this diagnostic technique is found in specific regions of the country and at specific hospitals. Before this screening method can surpass colonoscopy, it has to become more widely available. Patients need this availability to create the client based numbers that will ultimately make CT colonography appealing to institutions that have yet to adopt the service. Cost of the study is another factor that will influence institutional decisions on whether to adopt this service. To date, there are only models available to determine cost-effectiveness. The model used was the Markov state-transition model comparing 3D CT colonography every 10 years and every 5 years to no screening. Results showed that a 3D CT colonography done every 5 years proved to be more cost-effective than either a test done every 10 years or no screening at all. The mortality rate decreased from 2.1% with no screening to 0.4% with 3D CT colonography done every 5 years (Vijan et al., 2007). It is known that compared to the cost of treating a patient with diagnosed colorectal CA, CT colonography is definitely cost-effective. More studies need to be done to determine the cost limitations or advantages of CT colonography as compared to optical colonoscopy.
Both CT colonography and optical colonoscopy require bowel preparation prior to examination. Many institutions offering CT colonography have developed their own protocols for bowel preparation. Much literature is available discussing whether cathartic agents and fecal tagging provide better outcomes. This has been shown to be true with the use of either sodium phosphate or magnesium citrate as cathartic agents. In studies performed by Macari et al. and Vogt et al, neither of those studies includes catharsis or fecal tagging. It was noted in both studies that the use of these would most likely increase overall accuracy compared to studies that implement catharsis and fecal tagging.

Efficacy of CT colonography will be the definitive factor as to whether this diagnostic test provides the viability to screen for colorectal CA in asymptomatic patients. Studies presented earlier all used different parameters looking at which was the most effective way to perform CT colonography. Lesions that showed overall accuracy as being the same and if not better than optical colonoscopy are those $\geq 10$ mm in size. Table 1 summarizes the results from different studies for lesions $\geq 10$ mm. Lesions that are $\leq 5$ mm still cannot be detected with the level of sensitivity seen in optical colonoscopy. Lesions that are measure 6-9 mm are in an intermediate zone with some studies showing sensitivities near optical colonoscopy and others showing sensitivity not where it needs to be.

Patients need availability, at a cost-effective price with parameters set that will offer CT colonography comparable to that of optical colonoscopy. Literature shows that at this given point CT colonography is comparable and sometimes better at picking up lesions $\geq 10$ mm than optical colonoscopy.
References


Tables

Table 1. Comparison of studies examining lesions ≥ 10 mm.

(Pickhardt et al., 2003) (Vogt et al., 2004) (Johnson et al., 2007) (Johnson et al., 2008) (Macari et al., 2004)

<table>
<thead>
<tr>
<th></th>
<th>Pickhardt et al</th>
<th>Vogt et al</th>
<th>Johnson et al</th>
<th>Johnson et al</th>
<th>Macari et al</th>
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* Sensitivity was based off High resolution video colonoscopy finding as a comparative marker
#Sensitivity based off double review by 2D and 3D mode of imaging at different slice thicknesses
+Sensitivity based off colonoscopy finding as a comparative marker
Abstract

**Objective:** To perform a literature review of published studies to assess the efficacy of CT colonography versus that of optical colonoscopy in asymptomatic patients.  **Methods:** Searches were done in PubMed using the terms CT colonography, virtual colonoscopy, efficacy of CT colonography, colon cancer screening, asymptomatic screening for colon cancer.  **Results:** 5 studies were analyzed using different parameters for screening of asymptomatic patients using CT colonography with a reference standard of optical colonoscopy. Studies ranged from CT colonography vs. optical colonoscopy, differing slice thicknesses of. both 2D and 3D modes of imaging for CT colonography, virtual 3D dissection using CT colonography vs. optical colonoscopy, and detection of large (≥10 mm) adenomas on CT colonography vs. optical colonoscopy.  **Conclusion:** CT colonography approaches the efficacy of optical colonoscopy for lesions ≥ 10 mm. For lesions that are ≥ 5 mm, there needs to be further work done to improve the efficacy of CT colonography.