Colonoscopy – Screening, Polyps, GI Bleeding, and Virtual Colonoscopy
Paul E. Wise, MD
Assistant Professor of Surgery, Colon and Rectal Surgery
Division of General Surgery, Vanderbilt University Medical Center, Nashville, TN

For the SAGES-sponsored post-graduate course at the SESC
Saturday, February 9, 2008; Birmingham, AL

Screening Guidelines

Colorectal cancer remains the second leading cause of cancer deaths in the U.S. with more than 50,000 people dying annually from the disease. The majority of these cancers are thought to develop from adenomatous polyps taking 8-15 years to develop and progress into a cancer. The fact that this common condition usually starts with precursor neoplasms that are asymptomatic justifies the use of screening to identify and remove these lesions before they become clinically recognizable, thus stopping the adenoma to carcinoma sequence. Screening has been shown to reduce mortality and be cost-effective. Screening timing and frequency is usually based on risk factors with higher risk individuals having personal or family history of colorectal neoplasia, high risk hereditary colorectal cancer syndromes, and/or the presence of inflammatory bowel disease. All other individuals, thought to be 70% of the population, are considered average risk for cancer developing. Average-risk patients should undergo any of the following starting at age 50: 1. colonoscopy every 10 years, 2. fecal occult blood testing (FOBT) yearly, 3. flexible sigmoidoscopy every 5 years, or 4. a combination of 2. and 3. above.

Colonoscopy decreases the risk of colorectal cancer incidence by 76-90% and has been indirectly shown to reduce cancer mortality. Because there is a significant incidence of proximal neoplastic lesions without the presence of distal colonic pathology, and the incidence of proximal lesions has been increasing, colonoscopy is believed to be a better screening tool than sigmoidoscopy (but not proven). Downsides of colonoscopy include risk of perforation and bleeding, risks of sedation, need for bowel preparation, risk of missed lesions (at least 6% for lesions ≥10mm), and overall cost (time lost from work in addition to procedural costs, etc.). A clear, complete colonoscopy in an average risk patient should be adequate for screening and performed every 10 years. This has been endorsed by many professional groups as the preferred (“gold standard”) screening method.

Yearly FOBT can be performed by a number of available methods and requires two samples from three consecutive stools. When a positive result is followed up by a complete colonoscopy, cancer-related mortality is reduced 15-33%. Samples obtained by digital rectal exam (DRE) have higher false positive rates, and a single yearly DRE has been shown to be a poor screening test in comparison to the multiple stool examinations as above (but likely better than none). Guaiac-based tests have the highest sensitivity of the available FOBT options, thus dietary avoidance of red meat and peroxidase-containing foods for 1-3 days prior to the test is recommended. Multiple surveys have shown poor adherence and understanding of these guidelines (only 26% of physicians...
followed them correctly), but they are effective when a positive FOBT is followed by colonoscopy.

Flexible sigmoidoscopy has been shown to lead to a decrease in distal colon cancer mortality as high as 80% (45% for all colorectal cancers), but does not show a reduction in deaths from more proximal cancers. Because of the low risk of developing neoplasia in the first 3-4 years after a screening sigmoidoscopy, it is recommended that it be performed every five years after a negative study.

Other tests that have not been recommended for colorectal cancer screening by most medical societies include the following: virtual colonoscopy (see section on VC below), double contrast barium enema (DCBE), and fecal DNA testing. If DCBE is performed, it should be done every 5 years and followed up with a colonoscopy if an abnormality is noted. DCBE alone has been repeatedly shown to be less sensitive than colonoscopy (even for polyps >10mm), offers no therapeutic benefit, and has not been shown to reduce cancer incidence or mortality. Fecal DNA testing is gaining favor as it has shown a 4 times greater sensitivity than FOBT in detecting cancers and 2 times greater for adenomas (51% sensitivity when compared to colonoscopy), but there have yet to be any studies showing reduction in cancer incidence or mortality. The techniques for fecal DNA testing continue to evolve, and there are currently no societies that recommend their use as a screening modality.

**Higher Risk Patients:**

Patients with one or more first-degree relatives with colorectal cancer or adenomatous polyps should have a colonoscopy at age 40 or 10 years younger than the age of the affected relative at the time of their diagnosis. If normal, follow-up colonoscopy should be every 10 years if the relative was ≥60yo with cancer or adenoma, every 3-5 years if the relative was <60yo with cancer, and every 5 years if <60yo with an adenoma. Second or third-degree relatives do not seem to lead to increased cancer risk, and therefore the patient should be screened as an average risk individual unless there is concern for an inherited condition (such as an autosomal recessive condition like MYH-associated polyposis) or multiple second-degree relatives are affected, in which case screening should start at the latest by age 40yo.

Familial adenomatous polyposis (FAP, an autosomal dominant condition with essentially 100% penetrance) patients and their family members at risk should all be offered genetic testing and counseling by trained individuals. Initial screening with colonoscopy or sigmoidoscopy is recommended at age 10-12 for at-risk patients with a positive genetic test or no testing done/available, followed by yearly sigmoidoscopy until age 40 and then every 3-5 years thereafter if no polyps are found. If negative genetic testing, sigmoidoscopy should be done very 7-10 years due to the concern for a false negative test until age 40, then every 5 years thereafter. Upper intestinal endoscopy should also be performed on patients with FAP as per guidelines not outlined here due to their risk for duodenal and gastric cancer.

Hereditary nonpolyposis colorectal cancer (HNPCC, an autosomal dominant condition with up to 80% penetrance) patients and their at-risk relatives should be offered genetic testing and counseling by trained individuals. Colonoscopy in patients who are gene positive or high risk should be performed every 1-2 years starting at age 20-25yo (or 10 years younger than the youngest affected relative at the time of their diagnosis) and
then annually starting at age 40yo. Other screening tests (e.g., endometrial biopsies, etc.) are recommended for these patients due to the high risk of other organ systems being at risk for cancer, but these will not be outlined here.

Inflammatory bowel disease affecting the colon (Crohn’s or ulcerative colitis) leads to an increased risk of cancer based on extent of involvement, duration of disease, family history of cancer, age at onset, history of sclerosing cholangitis, and/or presence of backwash ileitis. There are no prospective studies confirming the efficacy of surveillance colonoscopy on colitis patients, but retrospective studies have shown mortality reductions from cancer in these patients with surveillance. It is recommended that colonoscopy be performed every 1-2 years starting 8-10 years after the colitis diagnosis for those with extensive colitis, and biopsies should be obtained every 10cm in 4 quadrants (minimum 32 biopsies) as the cancers in IBD are usually flat and may be difficult to discern visually. High grade dysplasia, multifocal low-grade dysplasia, or a dysplasia associated lesion or mass (DALM, or dysplasia in a bed of colitis) would warrant colectomy due to these being cancer markers for the entire colon. Unifocal low grade dysplasia in colitis is controversial as to whether the patient should undergo colectomy versus continued surveillance. An isolated dysplastic lesion free from colitis can be treated like a sporadic polyp in average risk individuals and do not warrant colectomy.

Surveillance:
Patients with previous colorectal cancer history should have a complete colonoscopy at or within 6 months of their original diagnosis due to the 3-5% incidence of synchronous cancers. After resection of a colon cancer, they should have a one year colonoscopy followed by a three year and then every five year follow-up colonoscopies if the results are normal. This has not, however, been shown to increase survival after resection of colon cancer but is based on the increased incidence of metachronous cancers in patients with a previous colon cancer.

Follow-up for rectal cancer is less well established, but recommendations from major societies include follow up colonoscopy in one year after resection with or without a 6 month post-resection sigmoidoscopy due to the 2-30% local recurrence rates. There are, however, no prospective trials of rectal cancer patients to assess the appropriate follow-up interval or establish survival benefits for post-resection surveillance. The general recommendations therefore, are otherwise similar to those for surveillance after colon cancer resection. Those rectal cancer patients who did not have a total mesorectal excision or did not receive radiation therapy for locally advanced rectal cancer should have a sigmoidoscopy every 3-6 months for the first 2-3 years after resection.

Patients with adenomas are at increased risk for metachronous neoplasia and have been shown to have a decreased incidence of subsequent cancer with follow-up surveillance. Patients with one to two <10mm tubular adenomas should have a repeat in 5-10 years, depending on personal and family history. Patients with ≥10mm adenomas, villous adenomas, high grade dysplasia or cancer in a completely resected polyp, or patients with 3-10 adenomas all completely removed should have a repeat colonoscopy in 3 years, assuming a complete colonoscopy in a well-prepped colon. If they have >10 polyps, or an incomplete or poorly prepared colon, they should have a repeat in <3 years. After the follow-up colonoscopy for these conditions, a repeat every 5 years is warranted if the repeat is normal. Patients with large, sessile adenomas that are resected piecemeal
should undergo repeat in 2-6 months, then every 5 years thereafter if normal, based on clinical judgment. Most patients with hyperplastic polyps, except those with hyperplastic polyposis, are considered average risk depending on family and personal history otherwise and should continue routine screening.

Newer screening modalities such as chromoendoscopy or dye-spray endoscopy, narrow band imaging, magnification endoscopy, and pill colonoscopy have not been established as effective means for surveillance or screening for all patients and are not equivalent in the hands of all providers. Further studies as these technologies evolve will establish their role both in screening as well as for surveillance after endoscopic or surgical polypectomy or cancer resections. They are only considered adjunctive at this time by most surgical and medical societies and warrant further study.

Management of the Difficult Polyp

As noted above, the purpose of screening and surveillance is to identify and remove colorectal polyps prior to malignancy developing thus breaking the adenoma to carcinoma sequence. The majority of polyps are removable through the routine means of cold or hot forceps or snares. Unfortunately, not all polyps will be amenable to easy removal with these techniques, but these difficult polyps (usually >2-3cm) are rare. Deciding between endoscopic versus surgical resection becomes crucial when evaluating these difficult polyps. This section will address the concerns of removing these larger or irregular polyps endoscopically.

The greatest concern, of course, is whether the polyp harbors a malignancy. Endoscopically resectable polyps usually have a 10-15% risk of cancer, as opposed to even larger polyps with a yet higher risk for cancer. There are no prospective studies on how to visually identify a malignancy in a polyp, but most endoscopists seem to agree that ulceration, friability, or induration in addition to tactile clues with a biopsy forceps such as fixation or being firm suggest that there is likely an underlying malignancy and surgical resection should be favored. Biopsies may be helpful but may suffer from sampling bias. In situations where a large polyp is identified incidentally on a screening colonoscopy, a simple biopsy rather than more aggressive resection may be warranted as the patient and/or endoscopist may not be prepared for the increased complications associated with a complex polypectomy. A repeat endoscopy after further discussion and informed consent is then appropriate. If a complex polypectomy is to be performed, the patient must understand that repeat procedures may be necessary to completely remove the polyp. Of note, polyps that take up greater than 1/3rd the circumference of the colon, encompass two or more haustral folds, or involve a diverticulum or the base of the appendix are rarely able to be removed endoscopically.

Large pedunculated polyps can often be removed with snare cautery techniques. The important aspect of removal of these types of polyps is to ensure that the blood supply through a thick stalk, which may contain substantial vasculature, is controlled prior to the polypectomy (although bleeding is uncommon after removal of these). This is facilitated by gently closing the snare and cauterizing the base of the stalk followed by firmer closure and cutting through the stalk with cautery above the initial cauterized base.
Alternatively, metal clips or endoloops can be placed at the base to provide hemostasis or the stalk can be injected with epinephrine. The base of the stalk may be tattooed with ink or carbon agents to allow for subsequent identification (endoscopically or surgically) if the polyp has a concerning appearance for malignancy. Follow-up surveillance endoscopy will be based on the final pathology and the Haggitt level (indicative of the metastatic potential) of any cancer that might be present (2-6 months to 3 years depending on personal/family history and the pathology). At times, piecemeal resection of the polyp head is necessary before a large snare can even get around the polyp to reach the stalk.

Larger sessile polyps (>15mm) will usually require piecemeal resection with a large snare cautery. While this is an effective means of removal, it requires meticulous removal of the complete polyp and capture of the pieces. This ensures that pathologic examination of the polyp will be complete, although the margins will be unclear when the specimen is resected in this fashion. Larger pieces might require basket retrieval, division of the larger pieces with the cold snare, or may necessitate multiple passes of the colonoscope to remove them. It is also advisable to utilize endoscopic tattooing techniques to identify the area again for subsequent endoscopic examinations of the site, as well as potential surgical resection if invasive cancer is identified. Both the resection area itself and the opposing colonic walls should be injected to ensure identification of the area surgically if necessary. Additionally, care must be taken to avoid perforation of the underlying wall during the resection (this may be facilitated by saline lift, described below). Retroflexion can also facilitate visualization and resection of difficult polyps, primarily in the rectum and right colon. Any remaining polyp tissue should be treated with argon plasma coagulation (APC) (or other coagulation techniques) and has been shown to be effective in decreasing recurrence of the polyp. It has been repeatedly shown in retrospective studies that endoscopic resection of large polyps can be performed safely with low risk of perforation (rare and often treatable non-operatively) or bleeding (2-24%, treatable medically or endoscopically).

Endoscopic resection of difficult sessile rectal polyps (lower and middle third of the rectum, primarily) might be best performed after performing endorectal ultrasound or other staging procedure (e.g., MRI with endorectal coil). This helps to ensure no invasive cancer or nodal spread is present prior to endoscopic removal. Endorectal ultrasound of rectal lesions is notoriously inaccurate after attempts at endoscopic removal due to the post-procedure inflammatory response of the local site and local lymph nodes, making determination of need for neoadjuvant chemoradiation therapy prior to resection difficult. Other modalities for removal of these polyps, such as transanal excision or transanal endoscopic microsurgery (TEM), should also be preceded by staging of the polyp unless the patient is not a candidate for radical resection if needed.

Submucosal injection of various agents has been utilized to elevate and facilitate resection of large sessile polyps in the colon and rectum by elevating the submucosa and base of the polyp away from the serosa. This not only decreases the risk of perforation but also increases the potential for complete excision. Agents include saline with or without methylene blue (to distinguish the layers), with or without epinephrine. Other agents used to slow absorption of the fluid and prolong the elevation effect during the polypectomy include 0.5% sodium hyaluronate and 0.83% hydroxypropyl methylcellulose. Carbon/ink solutions can also be used to both tattoo the area for
subsequent identification as well as elevate the polyp. The volume of the agent to use is not standardized, but injection of 1-4mL at a time to create swelling of the submucosa, and up to 20-30mL or greater may be needed for larger polyps. Injection distal to a polyp (along the front edge) may obscure the view and make polypectomy more difficult. Therefore, starting with proximal injections (far edge of the polyp) may facilitate the lateral and distal injections, and view and subsequent removal of the complete polyp. Care must be taken to ensure only inclusion of the polyp and its surrounding mucosa in the snare as accidental inclusion of adjacent folds or mucosa can potentially lead to perforation. Failure of the polyp to elevate at the time of submucosal injection despite appropriate swelling of the submucosa (“non-lifting sign”) is concerning for invasion of the polyp into the submucosa or deeper and should therefore indicate need for surgical resection. The non-lifting sign may be falsely positive if a previous biopsy of the polyp has caused scarring in the area.

At the time of surgical resection for an endoscopically difficult polyp, intraoperative colonoscopy is a technique useful for localizing non-palpable or softer polyps which have not been pre-operatively tattooed. This can complicate a surgical resection, however, due to insufflation of the colon and potentially the small bowel. Maneuvering the colonoscope in the open abdomen can also be a challenge without the abdominal wall to provide counter pressure and limit the colon’s mobility. However, the surgeon can frequently telescope the bowel over the scope itself to an area known to be proximal to the lesion and then the mass can be found on pull-back while desufflating the colon.

Intraoperative colonoscopic polypectomy has also been useful in conjunction with laparoscopic confirmation of complete polypectomy without perforation, especially when performed in combination with the use of carbon dioxide as the insufflating gas rather than room air (facilitates reabsorption and colonic decompression). While the endoscopist identifies the mass, the surgeon performs diagnostic laparoscopy to examine the affected area of the colon as well as the remainder of the abdomen for other pathology. Other trocars may be placed to allow for manipulation of the bowel at the same time. As the polyp is excised endoscopically (with or without lift techniques), the exterior of the bowel can be observed for perforation or near-perforation. If this occurs, or there is an area of concern, this can be repaired or oversewn laparoscopically while the polyp is removed and examined by frozen section by the pathologists. Any invasive cancer or concerning features may warrant immediate laparoscopic colectomy, which would be discussed and consented to pre-operatively by the patient. This may necessitate unwarranted reservation of surgical block time if a resection is not needed, but would require only one general anesthetic for the patient. Inaccuracy of the frozen section (if the initial pathology was benign but permanent sections showed cancer or other concerning features) might necessitate a subsequent operation. Alternatively, the diagnostic laparoscopy ± bowel repair can be completed and the final permanent (rather than frozen section) pathologic examination performed – usually taking 2-3 days – after which the patient can undergo resection if needed.

Role in Lower GI Bleeding

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Lower GI bleeding (LGIB) accounts for 0.5% of hospital admissions in the U.S. and 24% of all GI bleeding events. It primarily affects males and the elderly (200 times more common in 80 year olds than those in their 20s), mean age being between 63-77yo. Mortality can be as high as 15% for those needing more than two units of blood transfusion, but is usually <5%. Most (80%) of LGIB stop spontaneously, but rebleeding occurs in at least 25% of cases. The majority of patients present with hematochezia but may have melena, hemodynamic instability, anemia, or abdominal pain as their main presenting symptoms.

LGIB is defined as bleeding occurring from a site beyond the ligament of Treitz. Common sources include diverticulosis (source of 17-40% of LGIB), arteriovenous malformations (AVMs, 2-30%), colitis (1-21%, including inflammatory, ischemic, or infectious), radiation proctitis, neoplasia (1-33%), or anorectal disease (5-10%). Other less common sources such as Meckel’s diverticulum, solitary rectal ulcer syndrome, aortoenteric fistulas, or post-polypectomy bleeding can also occur. The LGIB source may be an upper GI bleed in 10% of patients, small bowel source in 2-9% (80% of these due to AVMs), and up to 10% of the time the etiology of the bleeding may not be found.

Once the initial resuscitation and stabilization of the patient with a LGIB has occurred, the search for the source is performed to allow for focused treatment. Modalities to localize bleeding such as upper endoscopy, nasogastric tube placement, contrast enemas, tagged red blood cell scanning, CT scanning, and angiography (with or without embolization or vasopressin infusion) are outlined in the citations listed. Pill or capsule endoscopy (as well as double balloon and push enteroscopy) can provide information about the small intestines that may not be identifiable with standard upper and lower endoscopy. Its yield may be as high as 92% in hard-to-identify LGIB, but cannot utilize other diagnostic (e.g., biopsy) or therapeutic (e.g., injection or coagulation) maneuvers. It also cannot always pinpoint exactly where in the small bowel the pathology is occurring unless near a known landmark such as the ileocecal valve. Surgical intervention is reserved for those who fail other maneuvers or remain unstable despite aggressive resuscitation and transfusions (>6 units in 24 hours). Upper or lower endoscopic assistance at the time of surgical resection may aid in localization. A directed intestinal resection is preferred due to lower morbidity, mortality, and rebleeding rates than with “blind” resections or total colectomy.

Colonoscopy provides a safe and potentially therapeutic means (for 10-15% of patients) to diagnose the source of LGIB in the majority of patients (diagnostic yield 48-90%), with an accuracy between 72-86%. The safety and accuracy are both significantly increased if preparation of the colon is performed prior to the endoscopy, assuming the patient is stable enough. The use of colonoscopy early in the evaluation of LGIB (within 8-24 hours of presentation) has been shown to decrease the length of stay and may be the only study needed to identify the source of bleeding in the majority of patients.

Therapeutic interventions with colonoscopy include epinephrine injection (usually 1:10,000 or 1:20,000 in 1-5mL increments up to 10 or 20mL, depending on concentration), contact coagulation, APC, heater probing, fibrin sealants, band ligation, and/or clip placement. For diverticular bleeds, any of these therapies have been shown to be effective in retrospective series when the offending diverticulum or vessel is identifiable, with the larger series showing lower than 15% rebleeding rates. A combination of epinephrine and coagulation appear to be most effective, but none of the
techniques have been compared head-to-head in prospective trials for the treatment of diverticular bleeding. Colonic AVMs, usually in the cecum, are effectively treated with APC, coagulation or heater probe. Careful treatment – due to perforation risk – of all visible lesions should be performed since the one offending AVM is rarely identified. Colitis rarely requires endoscopic intervention (only if a focal area of bleeding or ulcer is noted) but may be best differentiated with endoscopic biopsies. Neoplasia can be treated endoscopically if able to be removed, but otherwise would require surgical intervention. Post-polypectomy bleeds best respond to cautery (early bleeding) or injection and coagulation or heater probe (late rebleeding). Anorectal disease (usually hemorrhoids or fissures) usually responds to medical management with stool softeners and/or laxatives, fiber diets, and Sitz baths, but may require hemorrhoid banding, infrared coagulation, or direct coagulation. Surgical intervention may be necessary if these options fail or the patient is anticoagulated. Radiation proctitis may respond to steroid or ASA suppositories or enemas, formalin application, or may require APC or other coagulation methods, including laser methods that have been shown to be effective.

Algorithm for Lower GI Bleed Assessment (modified from Green and Rockey8)

Virtual Colonoscopy1,8,9

CT colonography or “virtual colonoscopy” (VC) was first developed in the mid-1990s as another alternative screening method for identifying colorectal neoplasia. This method utilizes information from CT imaging (usually using multidetector CTs and sophisticated software) after distending the colon with air or gas with transanal insufflation. This allows for the creation of 2D and 3D endoluminal images (and “fly-through” simulations) of the entire lower GI tract for assessment of polyps or other abnormalities. While this offers no therapeutic potential, it does provide information about the other abdominal structures just as a routine CT scan would (11-15% frequency
of incidental findings of which 3-5% are thought to be clinically relevant). Although this screening method has gained acceptance in many communities, it has yet to reach widespread acceptability as the primary means of colon screening for average cancer-risk populations. Additionally, the majority of the studies published on this screening method were performed on high risk patients at larger institutions with sophisticated equipment and radiologists experienced in reading these specialized scans (i.e., some having performed >1000 studies), making the procedure’s wide-spread applicability for screening more suspect at this time. Reimbursements for VC are also variable (not covered by Medicare), and therefore these studies are primarily performed under study protocols or with other support.

Current acceptable indications for VC include the following: 1. An incomplete or failed colonoscopy (alternative to DCBE) – especially in the setting of an obstructing mass precluding more proximal evaluation that may affect surgical interventions (5% incidence of synchronous disease in the presence of a primary cancer). 2. Inability to perform colonoscopy, primarily due to comorbidities or inability to sedate/allergy to sedation. Other relative indications include patient refusal to undergo colonoscopy despite clear indications, or evidence of extrinsic compression on the colon at time of colonoscopy or DCBE. Regardless of the indication, the inability to perform therapeutic maneuvers with VC would require a subsequent colonoscopy or an operation if any pathology is discovered (thought to be >15% of screening VC), which must be understood by the patient if they choose to undergo VC.

VC does not (necessarily) avoid the need for bowel preparation, universally the most adverse aspect of colonoscopic evaluation as reported by patients undergoing standard colonoscopy. Bowel preparation is usually necessary as residual stool and/or fluid may camouflage or masquerade as colonic pathology on VC. This is a disadvantage of VC over colonoscopy as this fluid or stool cannot be irrigated or aspirated during the procedure. Fecal tagging with contrast agents the few days before VC can allow for “electronic” or “digital” cleansing while avoiding a mechanical bowel prep by allowing the CT software to subtract out the stool and just analyze the mucosa. This shows promise in allowing prep-free examination of the colon by VC with some studies showing accuracy rates of 100% for polyps ≥10mm using this technique.

The VC technique requires placement of a catheter into the rectum and insufflation of the colon using air or CO2 and performing the imaging in both supine and prone positioning to improve detection of polyps ≥5mm more than 15% over supine positioning alone. The insufflation carries a perforation risk – usually due to older age, colon-containing hernias, diverticulitis, or obstructing masses – of <0.1% in most larger studies. IV contrast is also sometimes given in patients with a poor prep or other overt pathology extrinsic to the colon on scout images, but is not necessarily used on all VC studies. This increases cost, time for the study, and potential for associated reactions or allergies but can improve the ability to detect smaller (<10mm) polyps. The lifetime risk of developing a cancer due to the radiation exposure from a VC for someone over age 50 is thought to be <0.1%.

VC accuracy has been the subject of extensive study and debate. Sensitivity for detection of polyps ≥10mm in single institution studies has ranged from 55-100% depending on the population studied and the technique used as well as the reader’s experience. The sensitivity for polyps 6-9mm (clinical significance of these lesions
unclear) has been between 39-94%, again, dependent on technique, etc. Three meta-analyses (between 1300 and 6400 patients in each analysis) have shown sensitivities and specificities for detecting polyps $\geq$ 10mm to be in the 85-95% and 95-97% ranges, respectively. Medium sized polyps (6-9mm) had lower sensitivities and specificities of 70-86% and 86-93%, respectively. These are thought to be equivalent to the sensitivity and specificity of the standard colonoscopy based on studies comparing two endoscopists performing repeat procedures on the same patients. Multi-institutional trials comparing standard colonoscopy and VC have also been mixed. One study with 1200 asymptomatic patients getting both studies in the same day showed VC sensitivity for $\geq$ 6mm polyps to be 89% (80% specificity) and colonoscopy sensitivity for the same polyps to be 92%. Another study of 600 symptomatic or high risk patients, however, showed VC sensitivity for 6-9mm polyps to only be 23% (52% for $\geq$ 10mm polyps) compared to colonoscopy sensitivity for 6-9mm polyps to be 99%. A final study comparing air-contrast enema with VC and colonoscopy showed sensitivities for $\geq$ 10mm polyps of 45%, 53%, and 99% and 6-9mm polyps of 30%, 47%, and 99%, respectively. It is likely that standardization of techniques and improved reader experience will improve the results and potentially make VC a useful screening tool that may increase screening rates and thus increase neoplasia detection and lower cancer rates. There are no studies to date showing reduced cancer incidence or mortality based on the use of VC, however.

VC Advantages
- Rapid test time (20-30 minute read time, however)
- Accurate for larger polyps ($\geq$ 10mm with most scanners)
- Incidental findings may be identified (11-15%)
- May be able to avoid bowel prep with fecal tagging
- No sedation required
- May be done if failed colonoscopy (due to obstruction, etc.)
- May increase screening rates
- Lower cost (overall) versus colonoscopy (debatable)

VC Disadvantages
- Requires bowel prep if no fecal tagging done
- Requires colonic insufflation (<0.1% perforation rate)
- Requires specialized software/techniques and CT reading skills/experience
- Less accurate for smaller lesions (<10mm, unclear clinical significance)
- Variable reimbursements at this time (not covered by Medicare)
- Non-therapeutic, thus requires follow-up colonoscopy if pathology identified
- Radiation exposure
- Unclear screening frequency guidelines as of yet
- Cost-effectiveness (overall) does not favor VC

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